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ABSTRACT

The use of games and gaming, which are simulated decision making, is examined in a paper addressed to the manager and administrator in higher education. Focus is on the use of games in situations of resource allocation for budgeting and long-range planning. Basic definitions and concepts are presented, followed by a discussion of the scope and nature of games and their development. Two games are identified as being currently used in higher education: USG and RRPM 1.6, each discussed in detail and evaluated as to uses and limitations. For further study there is an annotated bibliography to complement specific footnote citations. Appendices include an annotated guide to the literature on RRPM 1.6. A systems flow chart is provided along with a listing of the computer program to enable the reader to run USG, and a numerical solution is given to complement the discussion of the logic in the text. The games are mathematical and computerized but there are no prerequisites in mathematics or computer science required of the reader. All need concepts are developed from elemental and primitive terms used in higher education. These concepts are illustrated by means of block diagrams. (LBH)

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PROGRAMME ON INSTITUTIONAL MANAGEMENT IN HIGHER EDUCATION

PROGRAMME SUR LA GESTION DES ÉTABLISSEMENTS D'ENSEIGNEMENT SUPÉRIEUR

GAMING MODELS IN HIGHER EDUCATION

K.M. HUSSAIN

PROFESSIONAL SEMINAR
PARIS 25, 26 and 27 NOVEMBER, 1974

MODELS AND SIMULATED DECISION MAKING FOR INSTITUTIONAL MANAGEMENT IN HIGHER EDUCATION

SEMINAIRE PROFESSIONNEL
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MODÈLES ET EXERCICES DE SIMULATION APPLIQUÉS A LA GESTION DES ÉTABLISSEMENTS D'ENSEIGNEMENT SUPÉRIEUR

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Gaming Models in Higher Education

by

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Document prepared for the IMHE Seminar on Models and Simulated Decision-making for Institutional Management in Higher Education.

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SECTION ONE : INTRODUCTION

This manuscript is addressed to the manager and administrator in higher education. It concerns the use of games and gaming, which are simulated decision-making. More specifically, we are concerned with the use of games in situations of resource allocation for budgeting and long-range planning.

Section two starts with basic definitions and concepts (including definitions on games and gaming). This is followed by a discussion of the scope and nature of games and its development.

Two games are identified as being currently used in higher education. These are USG and RRPM 1.6. They are discussed in some detail in Sections 3 and 4 respectively followed by their evaluation and comparison in Section 5. Finally in Section 6 there is an evaluation of games : its uses and limitations.

For further study there is an annotated bibliography to complement the many citations to specific references made as footnotes in the text.

There is reference material in the appendices. It includes an annotated guide to the extensive literature on RRPM 1.6. There is no such material easily accessible on USG and hence this appears in the Appendices. It includes a systems flow chart and a listing of the computer program to enable the reader to run USG himself. Also included is a numerical solution to complement the discussion of the logic in the text.

The games discussed are mathematical and computerised. However, there are no prerequisites in mathematics or computer science required of the reader. All needed concepts are developed from elemental and primitive terms used in higher education. These concepts are illustrated by means of block diagrams.

SECTION TWO : BASIC DEFINITIONS AND CONCEPTS

2.1 Definitions

A common use of the word "game" is the activity played for pleasure and recreation such as chess, checquers or dominos. In this monograph we are also concerned with games, but one of a very serious nature. In it the participants (called players) work in groups (called teams) on a problem. They take decisions of an economic nature such as level of price, the rate of work or production and the allocation of resources. The results of these decisions are calculated somewhat as if the decisions were made in real life. Based on these results (called feed-back) the teams make further decisions. Again, they are informed of the results knowing whether they made good decisions or bad decisions. In a sense then, this type of game is a decision-making-laboratory much like a science laboratory. In it, one can experiment such as not allowed in real life and make mistakes without the implications of the costs of such mistakes were they made in real life. Also, the decisions are made rapidly without waiting for months or years as one would in real life. Thus the results of decisions of many years of real life can be compressed into a short time. The real world is simulated and (immitated) but, in spite of the artificiality of the game world, there is learning resulting from the playing of the game.

There are other benefits of such games and these will be discussed later along with examples of such games in the context of their historical development. First, however, we need to define some other terms that are similar or related.

One is gaming. This is the use of games as defined above but distinct from operational gaming that is concerned with the finding of optimal solutions. These terms[1] are also distinct from the "Theory of Games" which is concerned with optimal economic

(1) For a further distinction of games and related terms, see A. Rapoport Rights, Debates and Games, or its French translation Combats, Débats et Jeux Translated by J. de la Thébaudière Paris : Dunod 1961.

behaviour and enunciated by von Neuman and Morgenstern.

2.2 History of Games

The earliest games were the Prussian War Games. The formal economic games of the type to be discussed in this monograph started with the AMA Game[2] in 1957. In the next four years, there were over 100 such games[3] largely business games, played by over 30,000 executives[4]. The game first to be used in a university environment was the University Administrator's Decision Laboratory[5] by IBM.

There have been other educational games[6] including one by Jim Gunnel[7] who was interested more in faculty recruitment and decision-making and one by Forbes[8] which was concerned with tuition rates, hiring of faculty, salaries, admissions standards, assignment of load, or the acquiring of equipment and space. But none of these games were concerned with how changes in curriculla affected resources required. They did not use the programmed concept of output nor did they use the PPBS (Program Planning and Budgeting System) approach for calculating the next year's budget and the long range plan. This had to wait till the late 60's and the acceptance of the PPBS concept into higher education along with the development of program budgeting models. In this context we can define a model as an abstract representation of a situation.

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(2) Franc M. Ricciardi, et. al., Top Management Simulation : The AMA Approach, New York : American Management Association Incorporated, 1957.

(3) For a description of many of these games, see J.M. Kibbee et al; Management Games, New York : Reinhold Publishing Corporation, 1961.

(4) R.C. Meier et al; Simulation in Business and Economics. Homewood Ill : Richard Irwin, 1969, p.182.

(5) W.W. Klaproth, University Administrator's Decision Laboratory, 360 version 1966, S/360 General Program Library, 360 D-15.1.001

(6) For a list and discussion of educational games see Derick Unwin "Simulation and Games" in P.J. Tansey (ed) Educational Aspects of Simulation. London, McGraw Hill, 1971,pp 247-267.

(7) J. Gunnel "University Faculty Recruitment : A Man Machine Game" in International Journal of Theory Design and Research, Vol. 11, No. 3, Sept. 1971, pp 349-375.

(8) J. Forbes. "Operational Gaming and Decision Simulation" in Journal for Educational Measurement Vol. 2 No. 1 June 1965 pp 15-18.

In this case the model was a mathematical model where mathematical statements were used to represent outputs resulting from a set of inputs or decisions. Repeatedly running this model would "simulate" or "immitate" reality.

Such models of simulation developed for higher education in the late sixties and early seventies. They include models like CAMPUS, CSM, RRPM, HELP, CAP:SC that were developed in the U.S. and HIS and TUSS developed in Europe[9]. But these models were fairly complex in structure and the concept of models and simulation were new to administrators in higher education. To train them on the structure and use of the model, it was necessary to develop gaming models that would be somewhat simpler than those to be used in actual decision-making. These models have since been used quite extensively and is the subject of the reminaing part of this monograph.

There are many such games that have been designed and used. Some have been superceded by more recent versions. Currently, only two exist. One is USG (University Sumulation Model) and the other is RRPM 1.6 (Resource Requirement Prediction Model, 6th version of model 1).

USG is the simpler of the two models. It corresponds to only part of RRPM 1.6. And this is the first part which makes it logical to discuss USG first. This is done in Section 3 followed by a discussion of the extension of USG in RRPM 1.6. This is done in Section 4. In both cases, we shall be concerned with a basic knowledge of the game model that is necessary to play the game and appreciate its capabilities.

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(9) For a discussion of these models, see Hussain, K.M. Institutional Planning Models in Higher Education, Paris : CERI at OECD, 1973.

SECTION THREE : U.S.G. MODEL

3.1 Introduction

USG was developed at the University of Utrecht in the Netherlands. It was designed to train people in the use of TUSS, the model actually used for resource planning and budgeting at the University. The main difference is that TUSS starts at the much more basic and detailed level of the courses taken by students and from it develops the load on the instructional personnel. Then, at the second level it calculates resources and some resource indices. It is for this second level that USG is designed. The game has been played not only by university administrators but also by students. At Utrecht, the students participate in university management and USG is designed to provide them (along with management) with an understanding of the variables involved and their inter-relationships.

The main calculated results of the USG are as follows :

- Surplus or shortage of teaching hours
- Salary cost for teaching
- Teaching cost per student
- Student/staff ratio
- Staff/assistant ratio
- Curriculum quality index

Note that we are basically concerned with resources and these are limited to resources in teaching. Given these resources we calculate ratios and indices to measure certain criteria. This is done for each "faculteit" or academic department. In the game, all the teams will be typically playing for the same department in order to be able to compare their performance.

But how are the output calculations made? What are the decision-variables or control variables (values determined and "controlled" by decision-maker) and parameters (values fixed and not controlled by decision-maker)? What are the assumptions and definitions involved? What is the significance or use of these calculations?

The answers to the above questions is the topic of this chapter. It will be attempted through a set of diagrams(Figure 3.1 - 3.8) of the flow of input and output, identifying by special symbols all the decision variables, parameters and outputs. These parameters and decision variables are also listed in one of the appendices on USG.

3.2 The logic of USG

In calculating resources required for teaching, USG takes the position that teaching personnel have three main responsibilities : teaching, research and "other" activities which include administrative work and public service. But the research and "other"activities are difficult to calculate or estimate directly. Therefore they are assumed to be a fraction of teaching effort. Thus the teaching effort becomes crucial to the U.S.G. model.

Teaching is done by two types of personnel : teaching staff that are professional teaching employees, and student assistants that are temporary employees. These are referred to as "instructional staff". In addition, there is staff employed in curriculum development who do not actively teach though they are typically teachers by profession. In USG they are personnel involved in developing and improving programs for self instruction. They are more a development investment rather than operational recuring teaching costs.

The instructional resources are considered a direct function of the effort by each student in that academic department. This is shown in Fig. 3.1 where one starts with a decision variable of the hours spent by each student (box 1 identified by the number on the top right hand corner of the box). Another decision variable is the distribution of the student effort in six different activities. These activities are :

1. lectures
2. self-instruction
3. small-groups
4. laboratories
5. exams
6. individual work

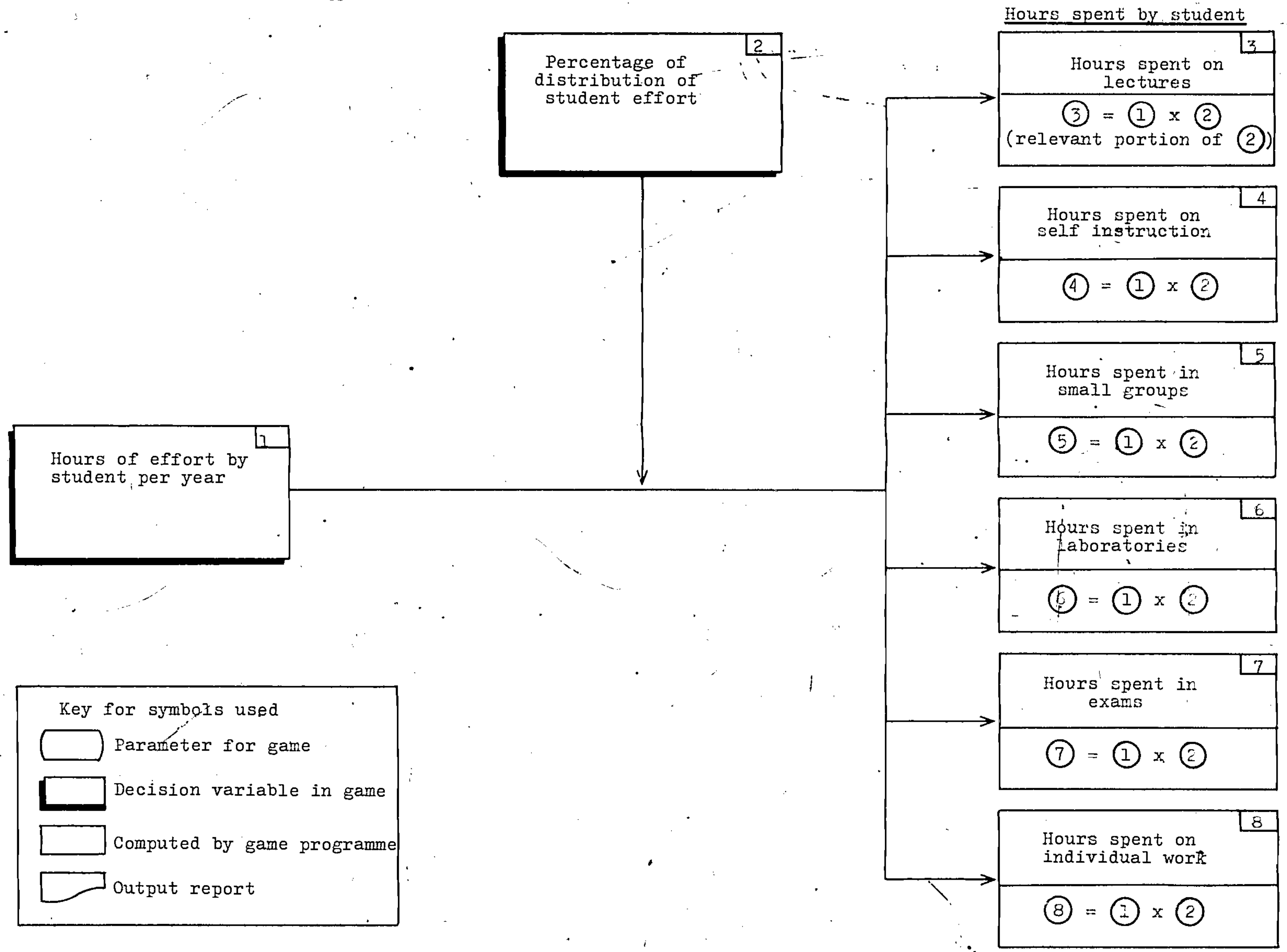


Figure 3.1 Student's effort distribution

This percentage distribution (box 2) when multiplied by the hours of effort by each student per year (box 1) gives the hours spent in each of the six different activities (boxes 3-8).

These hours of effort are converted to teaching resources required, but different types of effort have different rules of computation. There are three of these types of effort. One includes lectures and self-instruction. This is independent of the number of students involved but is dependent on the number of levels of students. These are discussed with Figure 3.2. The second type includes small-groups and laboratories that are dependent on the number of students and maximum class-size. This type is discussed with Fig. 3.3. And finally, there is the third type that is only dependent on the number of students. This type is discussed with Figure 3.4. Each figure will now be discussed in turn.

The hours spent in lectures by a student (box 3 in Fig. 3.2 and calculated in Fig. 3.1) is multiplied by the ratio of instructional staff hours per hour of student (oval box 9) to give the hours spent by instructional staff for lectures (box 10). The calculation is represented as 10 = 3 x 9 in the box 10. Similarly, the hours spent in self-instruction per student (box 4) when multiplied by the ratio of hours of instructional staff for each hour by student (oval box 11) gives the total hours of instructional staff for self instruction (box 12). When this is added to the hours spent on lectures (box 10), we get the total hours spent by instructional staff on lectures and self-instruction (box 13).

In these sets of calculations we have used parameters for the first time. These were the ratios of hours spent by instructors per hour by student in lectures and self-instruction (oval boxes 9 and 11 respectively). In the TUSS model, these would be decision variables. In the game version USG, their values are fixed and hence they are parameters. This reduces the number of decision variables in the game. It may reduce the flexibility of the game but it makes the game faster to run and conceptually simpler to comprehend. Also, if there are too many decision-variables that are changed in each play of the game, then it is difficult to identify which variable or relationship caused the change in output.

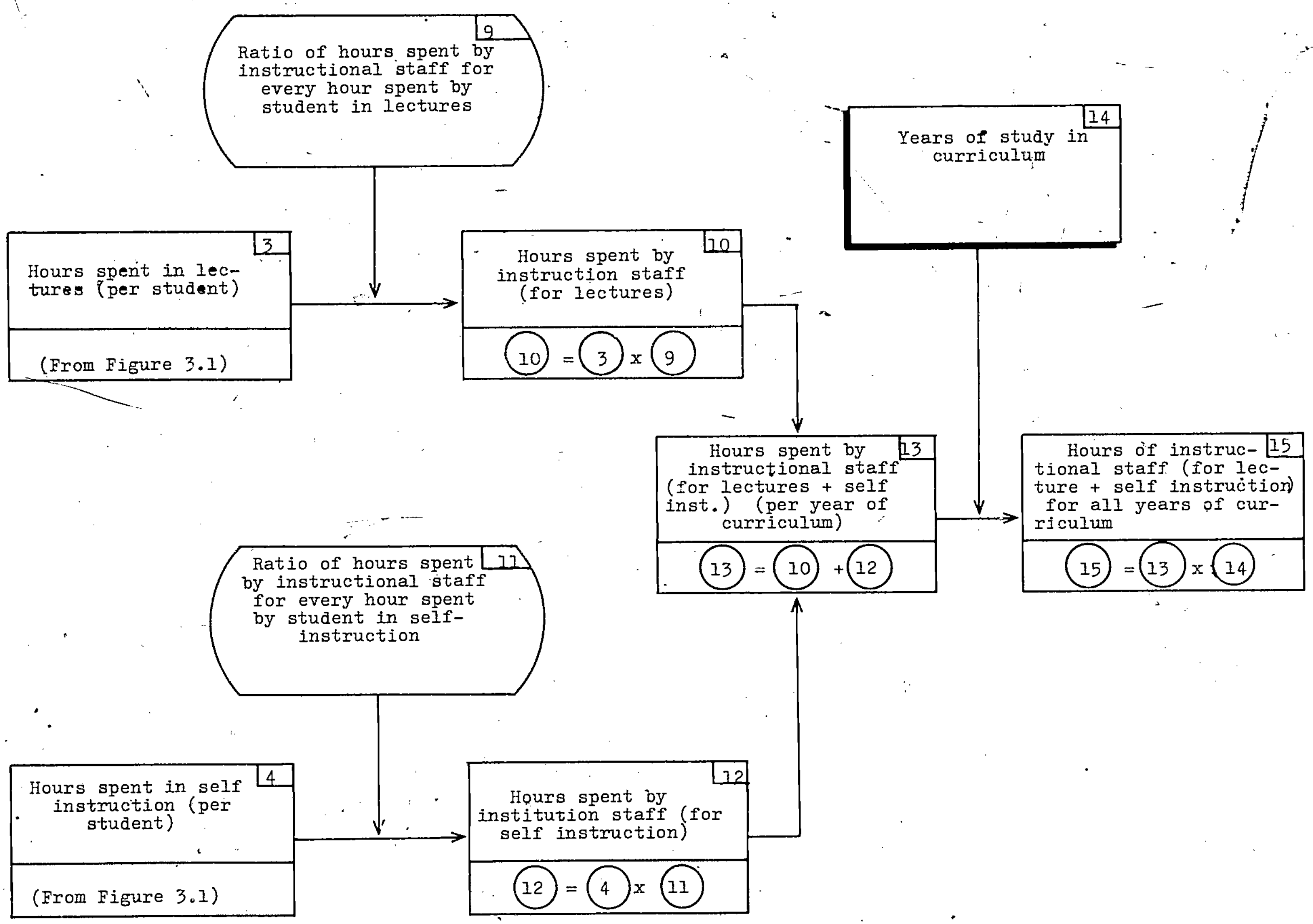


Figure 3.2 Calculations for lecture and self instruction

For these reasons the game designer retains the important game variables (necessary for **a realistic** environment) as decision variables and fixes the remaining values as paramaters. This is the prerogative of the designer based on his objectives and perception of the environment that he wishes to simulate. He always has the problem of selection so as to balance realism of the environment with simplicity and ease of playing the game within specified boundaires of the environment. However, if a user wishes to change the environment, or some of the parameters with decision-variables, he can theoretically do so. It would involve some computer reprograming and changing the input forms.

Back to Fig. 3.2. The hours spent for the instructional staff calculated (box 13) was for one year since the hours of effort per student we started with (box 1) was for 1 year. This is <u>assumed</u> (perhaps a heroic assumption) to be the average for all the levels of the student. Thus the total instructional hours for the institution (box 15) would be the hours per year (box 13) multiplied by the number of levels of the student which is the same as the years of the curriculum (box 14).

Note that the instructional effort is a function of the hours spent by each student. This implies independence of the number of students involved. This relationship is somewhat obvious for self-instructional activities like courses taught through CAI (computed-aided-instruction), programmed instructional texts, TV or audio-cassettes. But in lectures (i.e. class meetings) there is typically a size consideration. In USG, however, the number of lectures is independent of the number of students. It is always one (i.e. the more students in the class, the larger the class room but still only one "lecture"). If, however, size is important or significant, then it is no longer called a "lecture" but rather a "small group" or a "laboratory", the latter typically requiring equipment and work of a practical nature. These types of meetings have staffing needs that must be calculated differently and this is shown in Figure 3.3.

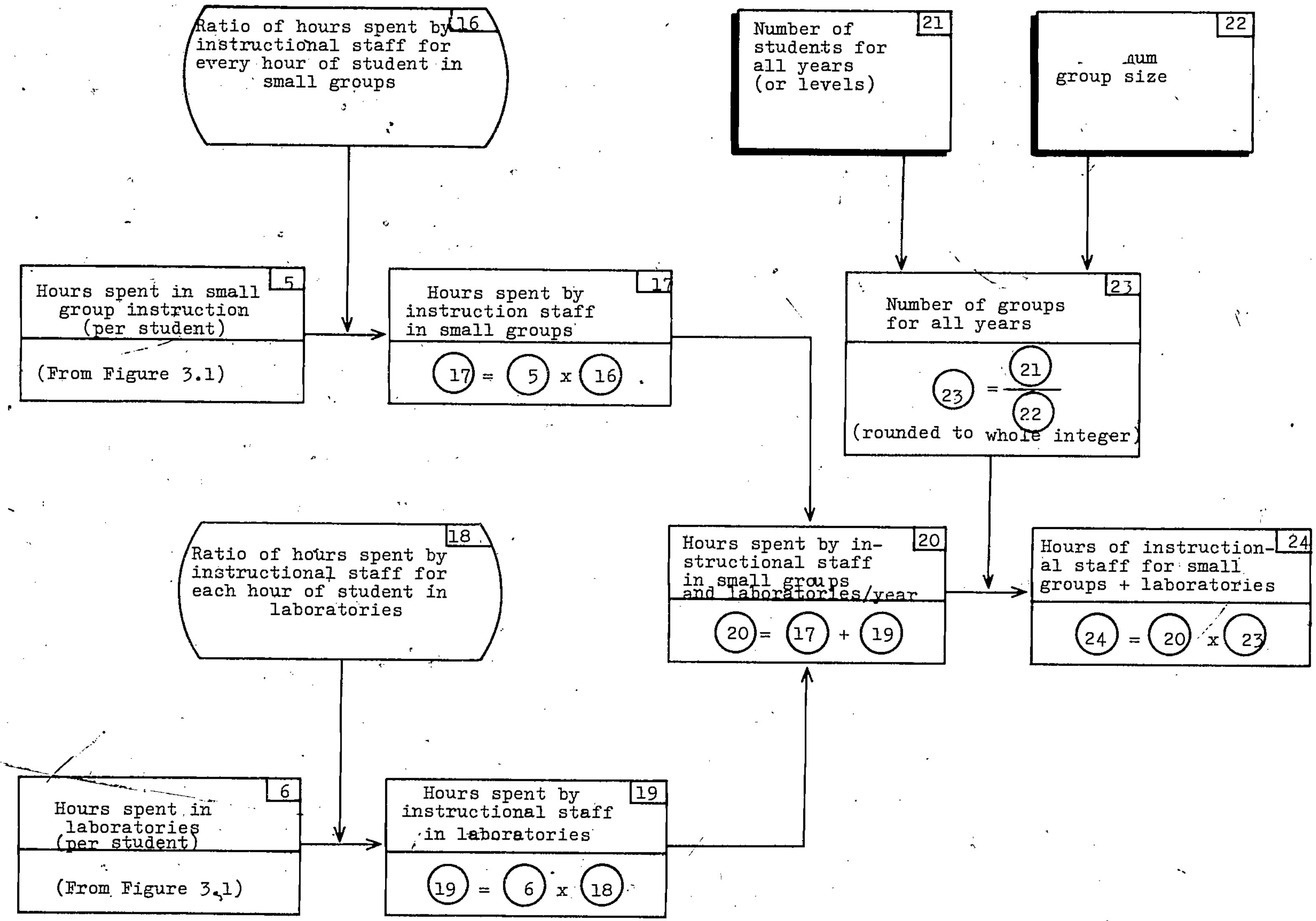


Figure 3.3 Calculations for small groups and laboratories

With small groups and laboratories we start off as with lectures and self-instruction. We take the hours spent by students in small groups and laboratories (boxes 5 and 6 respectively) and multiply each by its ratio of hours spent by instructional staff to student (oval boxes 16 and 18 respectively) to give the hours spent by instructional staff in small-groups or in laboratories (boxes 17 and 19 respectively). These when added together give the hours spent by instructional staff in groups and laboratories (box 20). This value, however, is for all the students assuming they were in one group. But by definition, small-groups and laboratories are size dependent. Thus the hours spent by instructional staff (box 24) will be the hours spent by instructional staff (as in box 20) multiplied by the number of groups of small-groups or laboratories. (box 23). The number of groups is the total number of students (for all the levels of students) (box 21) divided by the maximum group-size (box 22). These latter two values are decision variables in the game, but note that the maximum class-size in USG is **independent of** the level of student. Typically this decreases as the level of student increases i.e. the average maximum class size for the 4th year is typically smaller than that of the 3rd year or certainly less than the 1st year student. Note again, an important assumption.

We now have the last category of student effort : exams and individual work. This is shown in Fig. 3.4. Again we take the time spent by each student (boxes 7 and 8) and multiply it by the ratio of instructional staff effort to student effort (oval boxes 25 and 27 respectively). Adding the two components for exams and individual work (boxes 26 and 28) we get the total instructional effort for exams and individual work (box 29). (Individual work includes such activity like thesis writing, excursion etc.)

The effort calculation (box 29) is for one student since the initial value of effort (boxes 7 and 8) was for one student. We must therefore multiply this (box 29) by the total number of students at all levels of the curriculum (box 21), which is a decision variable, to give us the total hours of instructional staff resulting from the responsibilities of exams and individual work (box 30).

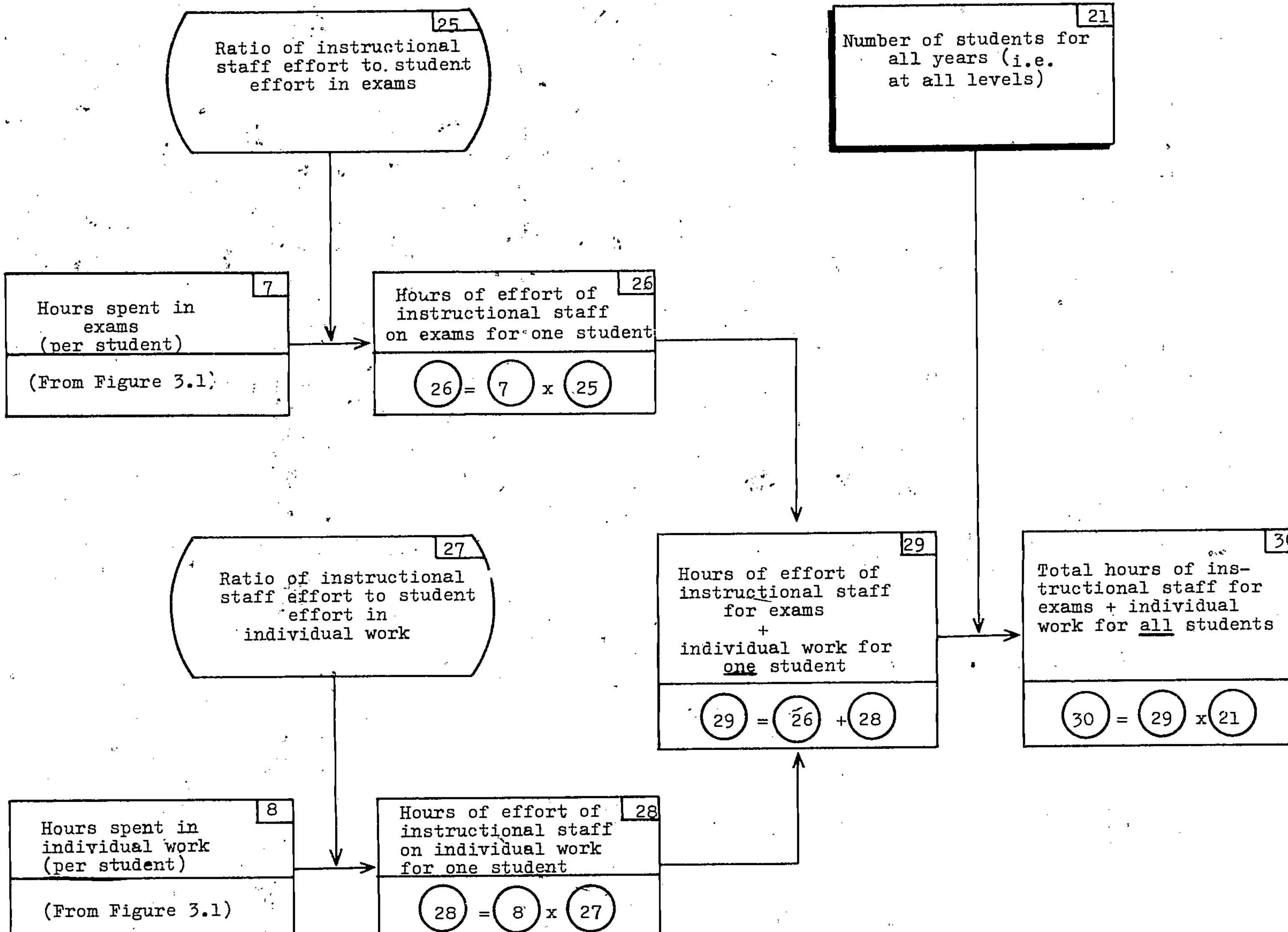


Figure 3.4 Calculations for exams and individual work

We can now add all the components of instructional staff effort (boxes 15, 24 and 36) to give us the total instructional staff effort in hours of teaching (box 31 in Fig. 3.5). This effort required must be compared with the effort available to give the shortage or surplus of effort. The effort available is first calculated in terms of full-time-equivalent persons (i.e. F.T.E.) This is done by adding the teaching staff available (box 32) and student assistants available (box 33). Both these are decision-variables. Their summation gives us the total instructional staff available for teaching (box 34) in FTE. Note that this does not include the staff for curriculum development because in the model they do not teach as such.

The FTE available must now be multiplied by the average hours of work per F.T.E. per academic year (oval box 35) which is a parameter in the model. This multiplication gives the total hours of instructional staff available (box 36). But not all this effort available goes to teaching (part of it goes to research and part to "other" activities). To determine the effort available for teaching (box 38) we need to multiply the hours of instructional staff available (box 36) with the ratio of time of instructional staff available for teaching (box 37) which is another decision variable.

The teaching hours (of instructional staff) needed for teaching (box 31) is then subtracted from the hours available (box 38) giving a surplus (if positive) or a shortage (if negative). This is a result that appears in the output (output report symbol 39).

We shall now discuss the calculations of the different ratios shown in Fig. 3.6. First the student-staff ratio. Staff here is defined as all staff available for instruction i.e. teaching staff (box 32), student assistants (box 33) and in curriculum development (box 40). All these are decision variables. This total staff (box 41) is divided by the total number of students (at all levels) (box 21) giving a staff student ratio (output symbol 42).

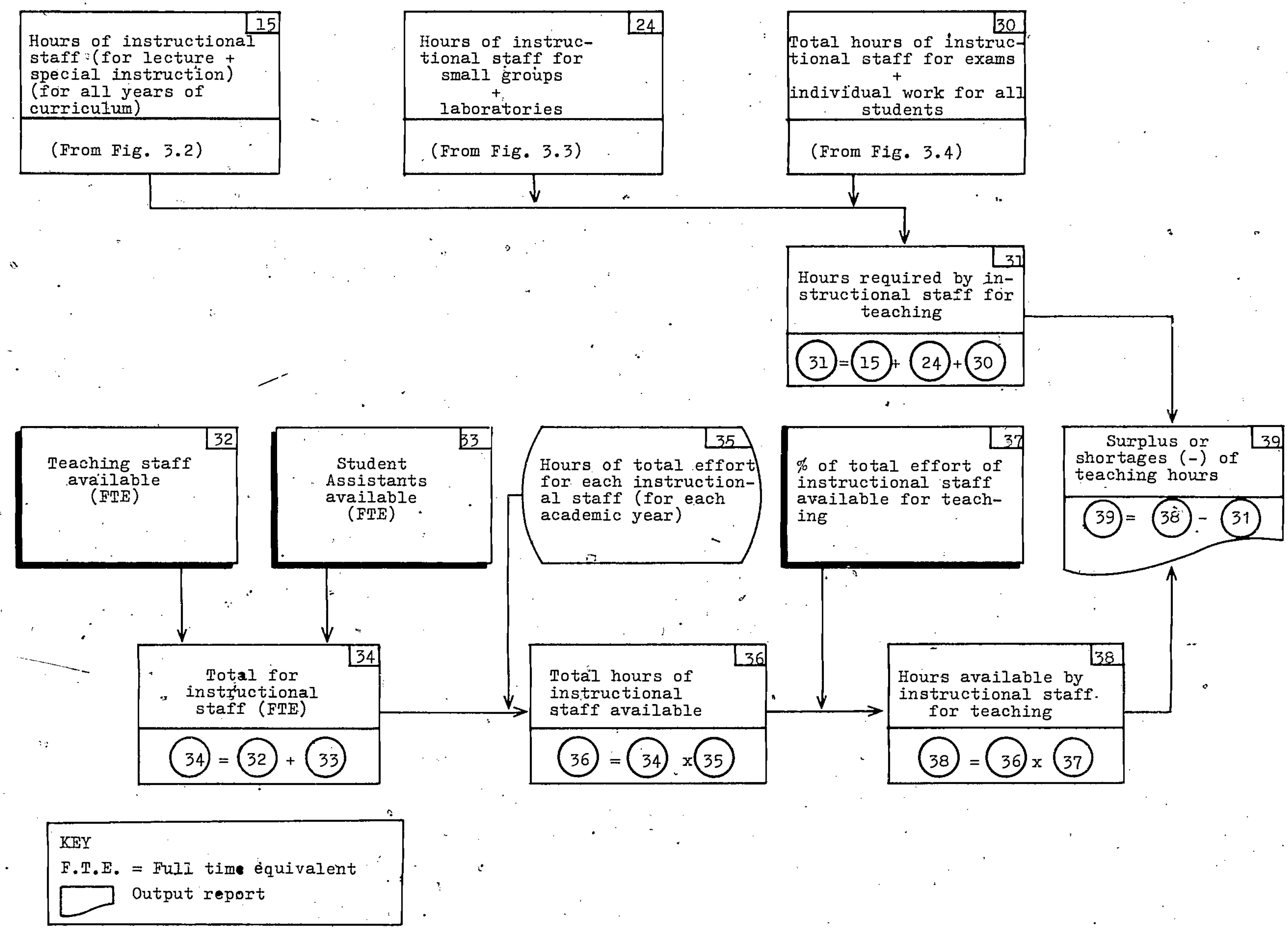


Figure 3.5 Calculation of instructional staff surplus or shortage

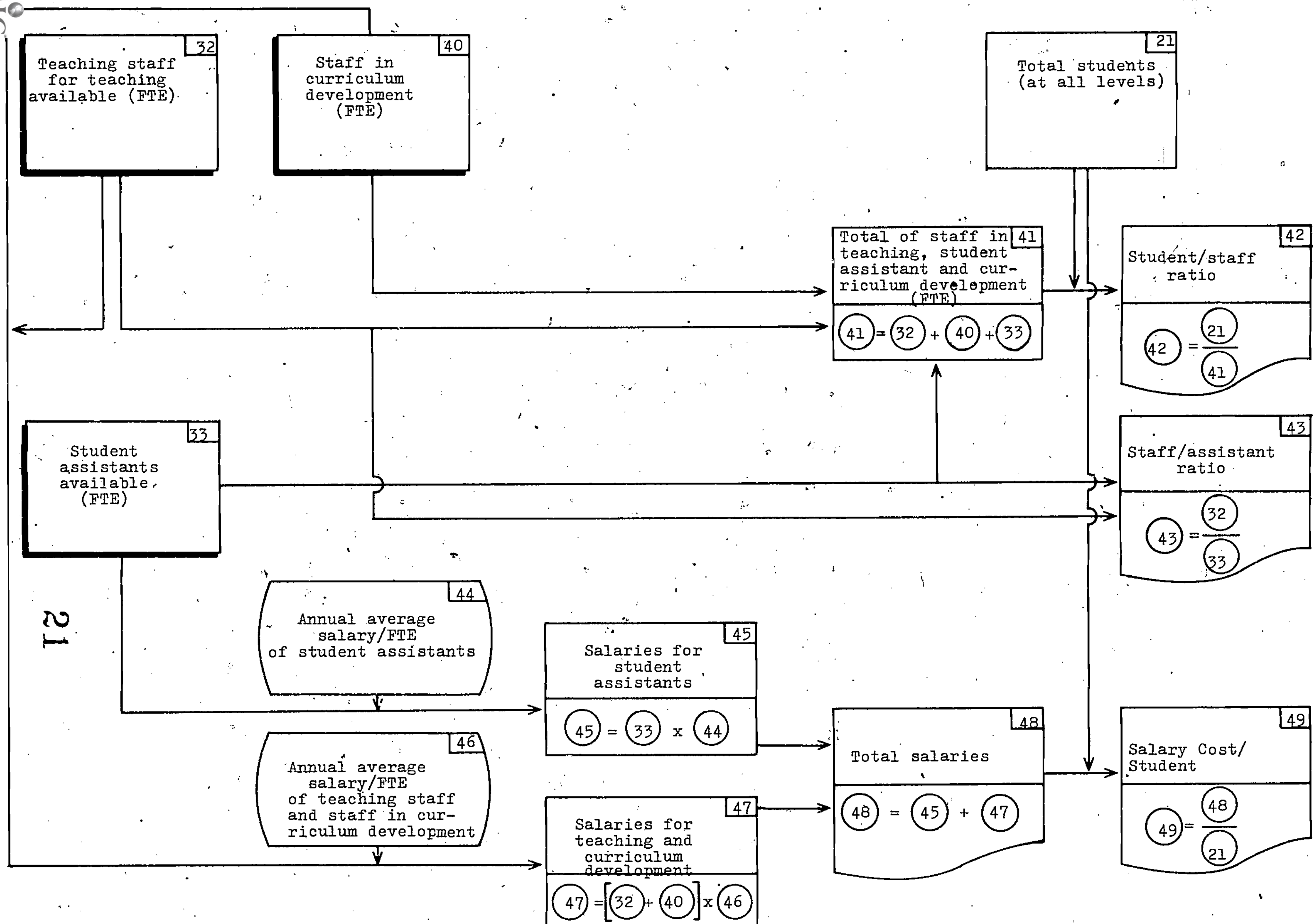


Figure 3.6 Calculation of Ratios and Costs

In the staff-assistant ratio, staff is defined as only the teaching staff available (box 32). This divided by the student assistants available (box 33) gives the staff-assistant ratio (output symbol 43).

The final ratio is cost per student. The cost here is only the salary costs. There are two average annual salary rates. One for teaching staff and staff in curriculum (oval box 46) which when multiplied by the sum of teaching staff (box 32) and curriculum staff (box 40) gives the salaries for teaching and curriculum staff (box 47).

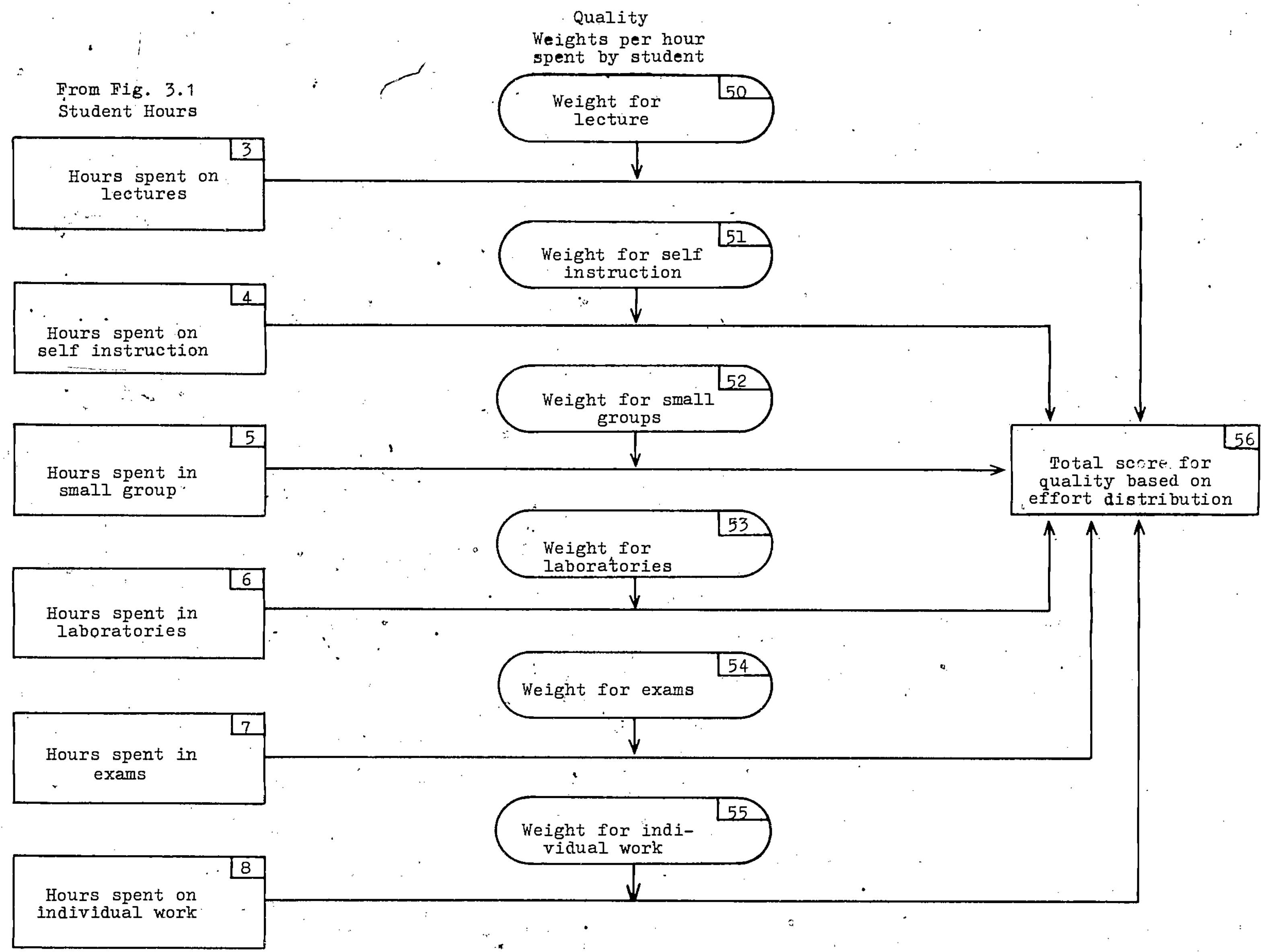
Note that in this calculation we assumed no ranking amongst the staff for purposes of salary. Only one average salary for all staff is assumed. One may argue with the assumption but the designer had the trade-off between simplicity and realism. The more the realism, the greater the complexity and less the simplicity. The designer chose simplicity without hopefully giving up much realism. The model could be expanded later to add realism and hence complexity[10]

The other salary cost component is for student assistants. This is determined (box 45) by multiplying the student assistants in FTE available (box 33) by the annual average salary for student assistants (oval box 44). This salary rate and the rate for the other staff are both parameters.

Adding the salaries for student assistants (box 45) with the salaries for teaching and curriculum development (box 47) gives total salaries (box 48) which when divided by the total number of students at all levels (box 21) gives the salary cost per student. (output symbol 49).

We have one more set of calculations. This concerns the "curriculum quality". It has two components : one is the weighted hours spent by each student and is shown in Figure 3.7; the other concerns class size and curriculum years. This is shown in Figure 3.8.

(10) For game design constructions, see Richard Bellman et. al; "On the Construction of a Multistage, Multi-Person Game" Operations Research Vol. 5 No. 7 August, 1952.



Note: (56) = [(3) x (50)] + [(4) x (51)] + [(5) x (52)] + [(6) x (53)] + [(7) x (54)] + [(8) x (55)]

Figure 3.7 Calculation of Curriculum Quality Index

The first component is the multiplication of the hours spent in each activity by each student (boxes 3 - 8) with its respective weights (oval boxes 50-55). The sum of all these weighted values gives a quality score (box 56).

The weights are parameters. For example, typically there would be a higher weight for small-groups than for lectures. This assumes that instruction would be better in small-groups and hence the quality of the curriculum (or the educational program) would be more enhanced.

The other consideration of curriculum quality is that of group size. This is shown in Figure 3.8. The quality score is calculated by the following formula:

Quality score = (No. of hours spent by student in small groups and laboratories/year) x 0.5x(15 - maximum group size for small-groups and laboratories).

In other words, as the group size increases the quality score drops because a larger maximum group size is considered directly proportional to lower quality of curriculum.

In Figure 3.8, the quality weighting formula for group size is shown (in oval box 57); the maximum group size (box 22); the hours spent in small groups (box 5); and in laboratories (box 6) are used to calculate the quality score for group-size (box 58). This when summed with the quality score for student effort distribution (box 56) gives the combined quality score for effort and group-size (box 59). This must be multiplied by the length of curriculum in years (box 14) to give the total curriculum quality score (box 60). This score is divided by a standard score (oval box 61) to give an index of curriculum quality (box 62).

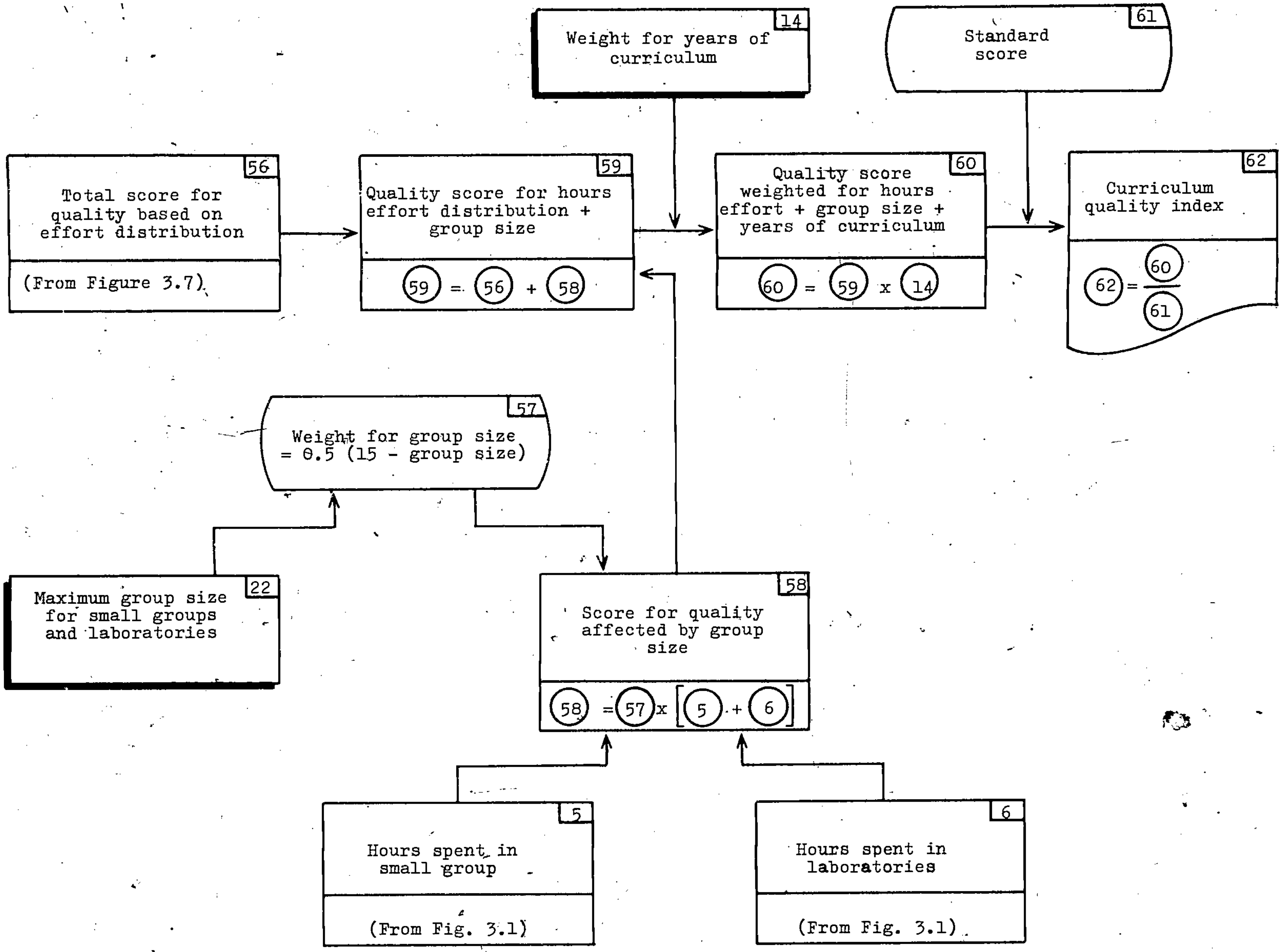


Figure 3.8 Calculation of Curriculum Quality Index (Continued)

This concludes the discussion on the basic logic of the USG model. It derives all the calculations that appear in the output, a sample of which appears in Fig. 3.9. The output also lists some decision variables and intermediate output for purposes of record for the game player. References of each line in the output to the text is shown in Appendix B. Also, as an appendix is a problem and its numerical solution illustrating every step of the computations made in the USG and corresponds to the flow diagrams in this chapter. It is designed to elaborate and reinforce the discussion of the logic in this chapter.

The logic of the USG model does indicate an important limitation : the scope of the model is limited not only to just the academic sector but to the teaching resources therein. This restriction is relaxed in another gaming model : **RRPM** 1.6. It is the subject of our next section.

UNIVERSITY OF UTRECHT BIOLOGY

	73-74
GENERAL DATA	
SHORTAGE/SURPLUS T-HOURS (IN 100'S)	-207.60
STUDENT/STAFF RATIO	25.00
STAFF/ASSISTENT RATIO	3.00
CURRICULUM QUALITY	90.65
SALARY COSTS (USD, IN 10000'S)	43.00
SAL-COSTS/STUDENTS (USD, IN 100'S)	8.60
CURRICULUM	
STUDENTHOURS/YEAR (IN 100'S)	16.00
PERCENTAGE LECTURES	40.00
PERCENTAGE SELF INSTRUCTION	3.00
PERCENTAGE SMALL GROUPS	10.00
PERCENTAGE LABORATORY	12.00
PERCENTAGE EXAMINATIONS	20.00
PERCENTAGE INDIVIDUAL WORK	15.00
CURRICULUM YEARS	5.00
PERSONEL	
STAFF IN TEACHING	15.00
STUDENTASSISTENTS	5.00
STAFF IN CURRICULUM DEVELOPEMENT	0.00
PERCENTAGE SPENT ON TEACHING	40.00
PERCENTAGE SPENT ON RESEARCH	30.00
PERCENTAGE SPENT ON OTHER ACTIVITIES	30.00
STUDENTS	
NUMBER OF STUDENTS	500.00
GROUPSIZE MAXIMUM	10.00
NUMBER OF GROUPS	50.00

<u>Figure 3.9</u>

Computer output for problem

SECTION FOUR : RRPM 1.6.

4.1 Introduction

RRPM is a family of models developed by the National Centre for Higher Education in the U.S. During the development of the first operational version, there was a need felt for a model that could be used for training management in a gaming situation. In response to this need, CEM(11) (Cost Estimation Model) was developed. Then came the first operational version, RRPM 1.3 with its own gaming subset called RRPM 1.35. All these were superceeded by RRPM 1.6 which is not only a gaming model but also one that is used for programmed planning and budgeting. In 1973 there were 127 institutional users of this model and the CEM(12).

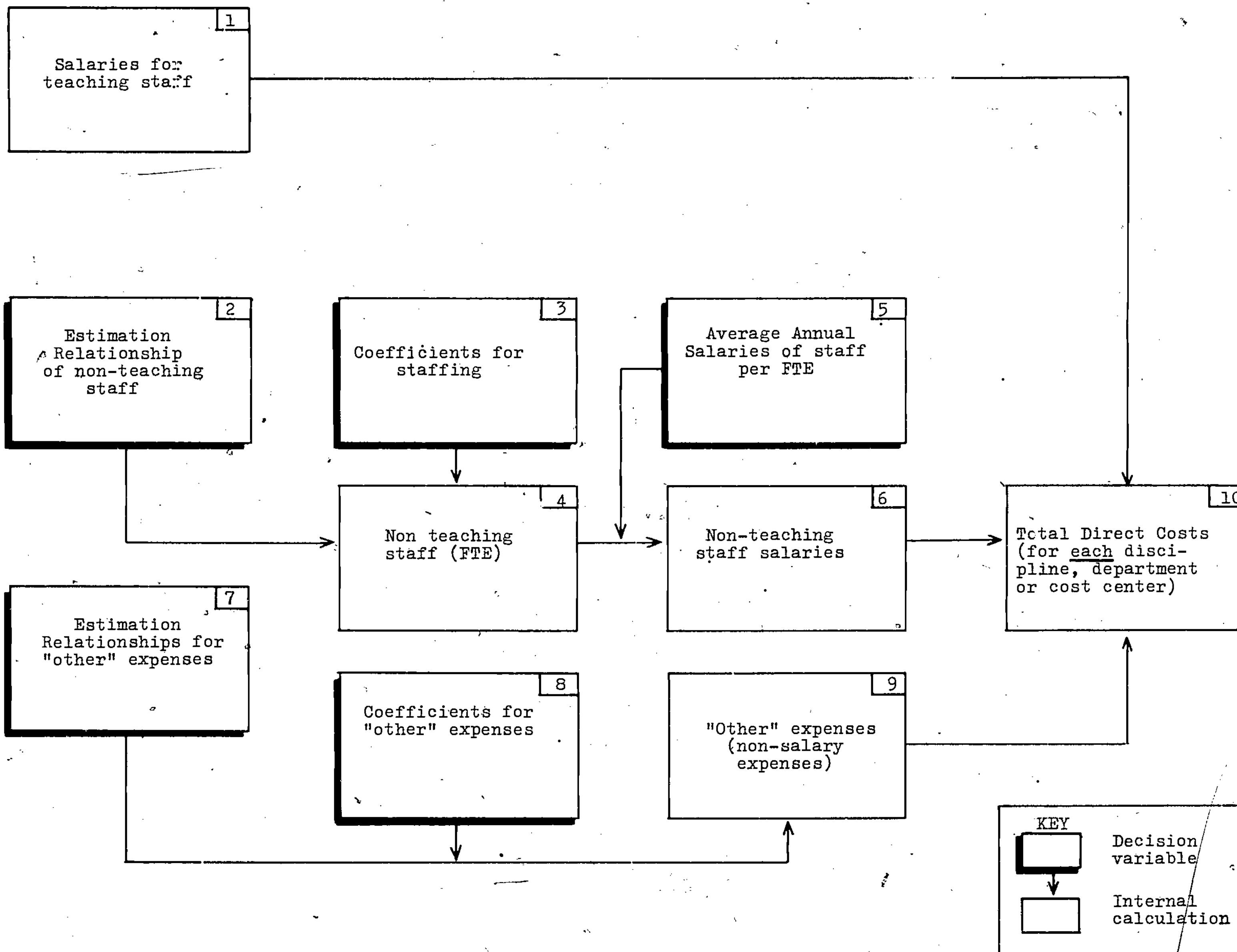
In the gaming mode, RRPM 1.6 can be used for decision-making at the instructional departmental level or at higher institutional management levels. It calculates all resources required for the academic and the non-academic sectors. It is this second sector and the non-teaching resources in the academic sector that does not exist in USG and it is here that RRPM 1.6 can be used as an extension or continuation of USG. The USG is more relevant to the European context and hence should be used in Europe for the teaching sector. It could then be extended to the rest of the institution by using RRPM 1.6. It is this extension that we are concerned with in this chapter. In it, we will examine the logic of this extension and in a somewhat brief and summary manner (we are concerned only with what is necessary to play the extended part of RRPM 1.6). For the detailed logic and numerical examples of solution (of the extension and the earlier part of the model), the reader is referred to Clark et al(13).

4.2 Partial Logic of RRPM 1.6

The partial logic of RRPM 1.6 to be discussed in this chapter is shown in Figures 4.1 and 4.2. We start with the salaries for the instructional staff (box 1 in Fig. 4.1). This is calculated in the U.S.G. or in the earlier part of RRPM 1.6, though the approach

(11) Springer Colby, Cost Estimation Model, Boulder Colorado : NCHEMS at WICHE.
(12) NCHEMS: Directors Annual Report, 1973 p.13
(13) Clark et. al. Introduction to the Resource Requirements Prediction Model 1.6. Technical Report No. 34A. Boulder Colorado: NCHEMS at WICHE 1973.

CALCULATIONS FOR EACH ACADEMIC DISCIPLINE OR DEPARTMENT OR COST CENTER



[illegible]re 4.1 Partial logic of RRPM 1.6 (page [illegible] 2) is very different. In USG, one allocates the student's effort while in RRPM 1.6 one develops the teaching load by using an Induced Course Load Matrix (ICLM). This ICLM approach is also used by TUSS, the model used at the University of Utrecht, which also developed the USG.

In addition to teaching salaries, there are in every teaching cost center, "other" salaries. These are for personnel like secretaries, student assistants doing non-teaching work and clerks. They need to be calculated for each cost center (in academic and non-academic sectors) and this is done either at the discipline or departmental level.

To calculate the non-teaching staff (box 4) we used a staffing relationship (box 2) and its relevant coefficients (box 3) which in the RRPM 1.6 are all decision-variables. The relationship is typically of the form :

$$Y = a + b_1 X_1 + b_2 X_2 + - - + b_n X_n$$

where Y = variable to be estimated

a = fixed coefficient

b's = variable coefficients

X's = the variables used for estimation purposes.

There is no practical limit to the number of X's that are used. They could also be zeros, in which case Y is fixed and Y = a. Typically, there is at least one X. For example, the staff (in an academic department) is a function of the number of teaching staff (or faculty). This then becomes X_1. In the case of the RRPM 1.6 this value is calculated in previous computations and is known to the computer program, (hence this is not shown in Figures 4.1 and 4.2). If, however, the variable were exogenous (external to the model) like the number of letter enquiries received by the department, then this variable must be provided. In most cases this does not occur and hence it is also not shown in Figures 4.1 and 4.2. But the functional relationship and the coefficients (fixed and variable if any) must be provided as decision-variables (boxes 2 and 3 respectively). This information enables the calculation of non-teaching staff (box 4) in FTE which when multiplied by the average annual salary of each staff (box 5) gives the non-teaching salaries (box 6) in the academic sector.

There may be more than one staff type each having a different average annual salary and a different estimation relationship and coefficients. In such a case, there must be a set of estimation relationship, coefficient and salary for each category of staff. Again this is not shown in Figure 4.1 for sake of simplicity.

Having calculated salaries, we need to calculate all other costs. These include supply, travel, communications, etc. This is a residual category to account for all non-salary costs that can be directly associated with the academic cost center. To estimate this cost component (box 9) we need an estimation relationship (box 7) and its coefficients (box 8). Again, as with staff costs, we may have more than one set if the categories are non-homogeneous for costing estimation purposes.

We now calculate the total direct costs for each cost center (box 10) by summing the teaching salaries (box 1), non-teaching salaries (box 6) and "other" expenses (box 9).

The calculation shown in Figure 4.1, is done for each of all the academic cost centers. All these calculations are shown as boxes 11 and 12 in Figure 4.2. They are aggregated (or summed) to give the total Direct Costs for all academic cost centers (box 13). What remains now, is the non-academic costs, also known as "overhead" or "support costs" or "indirect" costs. This is calculated (box 16) with <u>one</u> functional relationship (box 14) and one set of coefficients (box 15). This cost when added to the total Direct Costs of all academic departments (box 13) gives the total institutional costs (box 17).

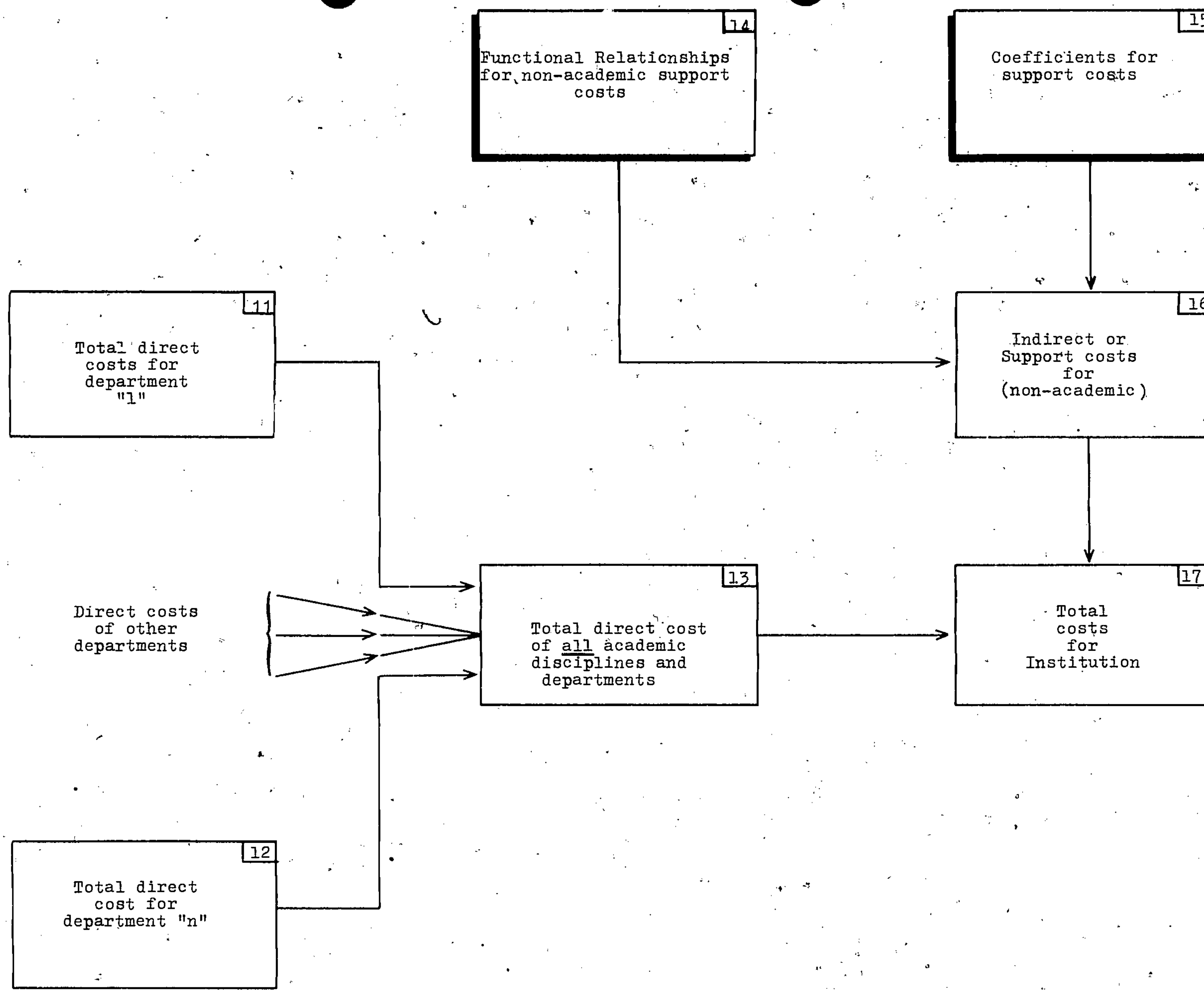
The functional relationships for non-academic support (box 14) and the academic support (box 7) are similar conceptually to that used for staffing (box 2.) Except, however, that in estimating support costs we specifically use more than one variable. Consider, for example, the supply cost used by a cost center of the department of chemistry. It may appear as follows :

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$$

Where X_1 = No. of student contact hours in lecturing (in the Chemistry department).

X_2 = No. of student contact hours in laboratories (in the Chemistry department).

X_3 = No. of teaching staff (FTE) (in the Chemistry department).


14
Functional Relationships for non-academic support costs
15
Coefficients for support costs
11
Total direct costs for department "1"
16
Indirect or Support costs for (non-academic)
Direct costs of other departments
13
Total direct cost of all academic disciplines and departments
17
Total costs for Institution
12
Total direct cost for department "n"

Then the coefficients are as follows :

a = fixed cost (independent of student or staff or other variable).
b_1 = supply cost per student contact hour in lecture (in the chemistry dept.)
b_2 = supply cost per student contact hour in laboratories (in the chemistry dept.)
b_3 = Supply cost per FTE teaching staff (in the chemistry dept.)

This type of relationship is not confined to RRPM 1.6 or for that matter to educational models. They are used many times in every day life. For example, it is used to calculate the taxi fare in most countries. When one engages a taxi, even without it moving an inch, the meter shows a cost - a fixed cost (coefficient a). To this is added the product of the kilometers travelled (X_1) and the cost per kilometer (coefficient b_1). Then, if there is a long wait, there is the product of the time waited (X_2) multiplied by the coefficient of cost per time unit waited (b_2). Also, if you have baggage, then there is an additional cost of the number of bags (X_3) multiplied by the cost per bag (call it the baggage coefficient b_3).

The relationship and the coefficients in our taxi example are determined by some bureaucrat responsible for such things and is programmed into the meter. Similarly, in the RRPM 1.6 model we need to state the relationship and coefficients. In the game version, this must be done by the team or players.

We need one relationship (or equation) and one set of coefficients for each support cost category and for each academic cost center. Note the large number of estimation equations for support costs for each academic cost centers and yet only one estimation equation for all non-academic support. In the earlier version of RRPM (i.e. RRPM 1.3) there were more such non-academic support equations(14) but the users found them difficult to state (15) and somewhat more difficult to determine the different cost coefficients. Hence the aggregation in RRPM 1.6.

(14) Hussain K.M. A Resource Requirements Prediction Model (RRPM 1): Guide for the Project Manager. Boulder Colorado: NCHEMS at WICHE 1971 p. 11

(15) See Hussain and Martin (1971) for experiences of pilot institutions that implemented RRPM 1.3.

There are some logic relationships that have been deleted. For example, RRPM 1.6 considers the salaries of a department chairman for each academic cost center. This has been deleted because it is not relevant to the playing of the game in the extended version. Also, in RRPM 1.6, the costs are allocated within each academic cost center to each course level. This enables calculating cost for each course level which when used with the ICLM, gives unit costs at each student level. A discussion of such costing will require a discussion of the ICLM, the credit hour concept, course levels and the curricula pattern which is quite different to the European environment. Therefore it is deleted. But again, the interested reader is referred to Clark et.al. 1973.

There are, however, many unit costs which are calculated and will be mentioned. These are :

1. Cost per student credit hour in each discipline for each course level.

2. Cost per student Contact hour in each discipline for each course level.

3. Cost per student in each academic program for each student level.

This constitutes a minimum discussion of the logic of the extension of RRPM 1.6 to the U.S.G. Some logical differences between the USG and RRPM 1.6 may be of interest to the reader and so it is the topic of the next section.

SECTION FIVE : COMPARISON OF GAMING MODELS

5.1 Purpose of Comparison

In this chapter, we will be concerned largely with the differences between USG and RRPM 1.6, though references will be made to other models as this becomes appropriate. Furthermore, in the case of RRPM 1.6, the comparison and evaluation will not be confined to the part of RRPM 1.6 that is the extension of USG but to the entire model. Finally, the comparison will be on the logic as well as considerations of implementing and running the model.

5.2 Evaluation of USG and RRPM 1.6

Of all the gaming models and their many versions, USG is by far the simpler both conceptually and operationally. To run USG, one can use a computer if available. The computer programs are written in a very simple set of the most common programme language (FORTRAN) and requires very little computer storage making it virtually useable on any computer. In case of a computer breakdown during the game, the game administrator need not loose a heart beat (as the author did in running RRPM 1.6) and can do the computations by using an adding machine or a slide rule. This is impossible in the case of RRPM 1.6, which requires not only a computer but one with the capabilities of running the COBOL language.

USG can be run either in the batch-mode or on a terminal. Its output is in either Dutch or English and will soon be also available in French. Thus it will cause few if any communication problems when run in Europe.

Even with its simplicity USG is able to convey the most important advantages of a simulation model. That is, the capability of generating answers to "what if" type questions; experimenting with different alternatives without having to pay possible adverse consequences of the decision; and finally forcing the players to analyse quantitative output and make trade-offs.

Because of the small demand on understanding the game and preparing the input, USG is very attractive as a first introduction to gaming in higher education. Within an hour, a newcomer to the game can start playing after being introduced to basic concepts of effort distribution, class sizes, teaching staff needs, and personnel ratios. Most important, and this is unique to USG, there is a quality index, albiet a controversial and debatable one. But an output index, the maximizing of which provides a goal and an objective oriented attitude in the game.

The outputs of USG can be displayed so that comparisons can be made. A team can make decisions for up to five years in the future and all the five year consequences can be displayed on one page. Alternatively, the decisions of up to five teams can be displayed for any one year. Such comparisons are not possible in RRPM 1.6 because there is a great deal of output for any one year. There is, however, the capability of comparing results of up to 9 different decisions in RRPM 1.35 (16).

In balance of some of its advantages, USG has some limitations including its heroic assumptions like the class size and ratio of instructional effort to student effort being independent of level of student. Also, the USG has a very limited scope. It considers only one academic unit. True the model can be run many times once for each academic unit. But even then there is a serious limitation. USG does not allow for any "crossing" between academic units. Students in one academic unit must take all their courses within that unit. In the university of Utrecht, when there are only five "faculteits", this is quite realistic. But there is a demand for more faculteits and academic majors with students taking courses in academic departments specializing in discipline areas. Thus a physicist may take Maths in the Mathematics department rather than be limited to the teaching of mathematics in the Physics department. This freedom from the boundary rigidities of the traditional educational system can be seen in many new European universities. An example is the New Lisbon University that will start in 1976.

(16) Gulko W.W. and K.M. Hussain, A Resource Requirements Prediction Model (RRPM-1) - An Introduction to the Model, Boulder, U.S: NCHEMS at WICHE, 1971, p.33.

The freedom of taking courses in departments other than that of one's major in RRPM 1.6, enables its players to question the consequences of different curricula requirements or different student preferences on the load of each department. Also, the player can ask organizational type questions : What if we were to close the Engineering College? How would it affect the load in the department of Mathematics, English etc? These questions can be asked in a game mode, but these are realistic questions facing many an administrator (or manager). The RRPM 1.6 answers such questions when used in the operational mode as a tool of planning and budgeting.

RRPM 1.6 generates the teaching resources as does USG, but in addition it projects the resources for non teaching personnel, (including administrative heads), as well as other support expenses. This is done for all academic units simultaneously, and then non-academic resources are calculated giving the total annual budget. This is the total operating budget not the capital budget. RRPM 1.6 (like USG) is not concerned with space and building. The earlier version of RRPM 1.35 did space calculations(17).

RRPM 1.6 does introduce the concept of institutional support costs and allocation of such costs to academic programs giving unit costs per student in each academic program as well as costs for a unit of production (credit-hour or contact-hour).

The additional calculations in RRPM 1.6 has a price that must be paid. The player has to invest more time in learning about the logic of the model and there are many input sheets that must be completed. But for someone using RRPM 1.6 in the operational mode, there is little incremental cost of learning to play the game. The benefits resulting from becoming acquainted with the mechanics and logic of the game are well worth his effort. Besides the game provides insights into the inter-relationship of variables and the process of decision-making that is valuable for anyone who has planning and budgeting responsibilities.

A summary of the above discussion is presented in a tabular form for easy reference. This is done in Fig. 5.]

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(17)See Hussain (1971) op. cit. p. 12.

Figure 5.1 : Comparison of USG and RRPM 1.6

	USC	RRPM
Calculation	Can be hand calculated + use of computer	Requires computer
Computer mode	. Batch . Terminal	.Batch
Computer related needs	. FØRTRAN	COBOL
Use	For gaming	For gaming + planning and budgeting
Scope		
. academic unit	**One at a time.**	**All at once.**
. sector covered	**Instruction only.**	**Instruction + support**
. resources included	**Teaching staff**	**Teaching staff + other staff + other support expenses**
Output	Teaching staff surplus or shortage (in hours)	Teaching staff needs (in FTE)
		"Other" Resource needs
	Teaching Salary Cost/ student	Total Cost (Direct + Support) for .student .program .Credit-Hour .Contact Hour
	Quality Index-	-

5.3 Scope of the Gaming Models

The scope of the model such as USG or RRPM 1.6 is a problem often debated amongst game designers. Thomas and Deemer[18] have the following view :

"When as in operational gaming, the increased difficulty of solution easily escapes notice, the temptation to enlarge the model becomes all the greater.. . But this temptation to elaborate should be the more strongly resisted in gaming. For to yield is to court delusion. Not only is there the doubly diminished effectiveness of solution mentioned before as a consequence of excessive elaboration, but there is also another difficulty that arises in interpreting the results of gaming. One tends to forget that the game is not reality itself. The "appearance of reality" so useful in teaching becomes dangerous in application".

In the above context, neither USG nor RRPM 1.6 are "dangerous" especially in Europe where the environment in each country is different and this is recognised. As for enlarging the model,[19] USG certainly cannot be criticised. RRPM 1.6, however, is an expanded model since it was primarily designed for operational use but this expansion can be reduced by changing decision variables into parameters for the game. Simplifying the model has other advantages : that of explaining and starting the game, of computation of results, of administrating its play, and finally, of easing and speeding the decision-making during the game.

Neither USG nor RRPM 1.6 are strictly competitive games. In the case of the USG, the administrator of the game may decide to state one objective for all the teams, such as maximize the curriculum quality index. Now if all teams are given the same starting

(18) Thomas C.J. and W.L. Deemer Jr. "The Role of Operational Gaming in Operations Research" Operations Research Vol. 5 No. 1 Feb. 1957.

(19) An extreme example of a complex game with a large number of variables is the Carnegie Tech. Game. It has 300 decisions each period and nearly 2000 items of information to analyse after each decision. It is, however, designed for experience in competition, negotiation, organization and reflection. For details, see Cohen H.J. et. al. The Carnegie Tech Management Game : An Experiment in Business Education. Homewood Illinois : Richard D. Irwin, Inc. 1964.

values of parameters and the same environment in the problem, then the game becomes competitive. But the game is not competitive (and neither game is) in the sense that the affect of the strategy of one team affects the result of the other teams strategy. Thus it is not a zero-sum game. It is a non-zero sum game because the loss of one team is not the gain of another team. They do not share the student enrolment population; they do not share the available funds; nor do they share the instructional staff availability. The game is fully deterministic with known parameters and known relationships. The game is not probabilistic nor is it stochastic. The teams are playing against "nature" which is typically neither benign nor benevolent. However, for pedagogical reasons, the game administrator may during the game change some parameters or even fix some decision variables. For example, he may announce that there is an unexpected change in the availability of funds for higher education and so all instructional staff will be increased by 20% (or decreased by 20%). Then "nature" is no longer neutral. Also, the game administrator may fix the share of a team (of students, staff or funds) based on past performance (such as a surplus of funds or staff) and then the game could approach a zero sum game but it is not structurally designed that way as are some business games[20].

5.4 Simulation models and Gaming models

One final topic : that of the difference between a game and a simulation model. We have made many references to RRPM 1.6 as being a game as well as an operational model used in decision making for budgeting and long range planning. In contrast USG is strictly a game. What then is the difference between a simulation model and a game?

Klaproth[21] makes the following distinction :

"While a management game used in a decision-making laboratory is a form of simulation, it is somewhat different from the type of simulation one would utilize to aid in the process of making an actual business decision. In the real problem context, one would have developed a simulation model specific to the particular organisation with parameters inserted to reflect the actual expected performance of the process within the organisation. The decision-

(20) A good example is the AMA game. For details see Fricciardi et. al. op. cit.

(21) W.W. Kloproth op. cit. pp 7-8

maker would "try-out" various choices and observe the results (he may also vary the parameters in an effort to determine what effect changing conditions might have on his various choices). Ultimately he would choose that decision which gave results most closely reflecting his objectives.

In the game situation, the participant is presented with a situation and told to make a set of decisions. This set of decisions is final, and while the participant can see the results of his set of decisions, he has no opportunity to "try again" under the same situation. This difference between the gaming situation and the actual utilization of simulation to aid in the decision-making process is due to the totally different objectives of the two approaches. The game utilized in the decision-making laboratory needs only represent reality to the extent that realistic results are obtained from the decisions put into it. The performance required of a specific simulation model used to assist in a decision process is much more exact."

There are other differences. Games can be competitive with malevolent opponents unlike a simulation model where one plays against "nature" which is benevolent. Also, games sometimes include elements of negotiation and bargaining like in the WARP Industries game developed in Sweden. The game, however, is typically more abstract from reality and there is more interaction between the human player and the bstraction.

In summary, there are differences in function and hence sometimes the separate design of simulation models and gaming models. And for a model that performs both functions (like the RRPM 1.6) there must be compromises in design. This task was simplified in the case of RRPM 1.6 because it is not a competitive model and it was intended to be simple in its structure even as a simulation model. It is thus much less complex and therefore much less closer to the real life situtation than is CAMPUS, the next most commonly used model in the U.S. It is also less conceptually complex in its academic sector than the European models HIS and TUSS though it has a larger scope in that it includes the non-academic structure, non teaching instructional costs and unit costs. Also RRPM 1.6 had the advantage of evolving from two other models, RRPM 1.3 and CEM. RRPM 1.3 was primarily a simulation model while CEM was primarily a game. In the extensive use of the CEM game, the designers learned much about modeling. Thus the game was used as a modeling technique. This use of a game will be developed further along with a discussion of other uses and limitations of games. This is the topic of our next and final section.

SECTION SIX : USES AND LIMITATIONS OF GAMES

There are at least three major uses of gaming : education on a model; training in decision making: and finally, gaming as a research tool. These uses are not always mutually exclusive, and hence their discussion will be somewhat collective. Following this, we shall discuss briefly some limitations of games.

6.1 Uses of Games

There is learning and discovery that often emerges from a game in spite of its artificialness and inconclusiveness. Goodman(22) describes this as follows :

"Games.. involve an experience which is dramatic without being decisive. The players in addition to having freedom to discover ends not predetermined, also have the freedom which comes from the tentativeness of the gaming situation. Although the game is exciting, involving, enraging even, it is never 'for real'. Similar to the traditional conception of the essay, games, too are tentative attempts which pretend neither to absolute truth nor to final outcomes. They are, rather, an exploration, and consequently winning and success may be relatively unimportant in the long run.....In games...winning has more to do with successful learning than with any score-keeping principle. It is as if every engaged player wins, perhaps not blue chips or a new contract, but some further insight, some glimpses, however tentative, of further discovery....What an indvidual discovers of a given choice within the rule framework is, however, more directly a function of his own skill and that of his competitors than a function of what his coach has said and done. Each rule he has received through the coach is something to be tested and evaluated (even a formal game rule): it is not to be accepted as an ultimate simply because the coach favours it, or even insists on it...He (the player) 'experiments' with the environment to 'discover' the rule for himself...he <u>acquires</u> an education through a process of <u>discovering</u> himself".

(22) F.L. Goodman, "In Introduction to virtues of gaming" in P.J. Tansey (ed) <u>Educational Aspects of Simulation</u> 1971. London : McGraw Hill, 1971. p.p. 28,30,36-37.

The gaming model is an abstraction of real life but this has its advantages. As Worth David(23) points out :

"...it enables the trainee (player of game) to assume a top level administrative role without forcing real people to suffer the consequences of a serious error in judgement. Free to experiment, to act without pressure to meet an immediate crisis with an adequate but **inefficient** solution, the trainee can concentrate on learning techniques of rational decision making. **Furthermore,** this freedom allows the trainee...to apply the criterion of efficiency to the broader purposes of the organisation...Finally, as advocates of business simulations have pointed out, the abstraction of the model provides a powerful diagnostic tool(24). Concentrating as it does on the essential elements of the process, it may bring previously **unrecognised problems and relationships to the** attention of the instructor as well as the trainee".

Gaming is often useful in the identification of the information needed for decision-making; extracting that information and then synthesizing and analyzing the available information. Two studies done by Dill and his associates(25) show that players improved in their ability to analyze and use data as the game progressed. One may question the transferability of this knowledge of information utilization (and principles of decision-making techniques learned in games) to the real world(26). But this is possible, given that there is some realism in the game model (as is true of USG and certainly true of RRPM 1.6) and a willingness and open-mindedness on the part of the player. There's some evidence that such a player can be taught to make rational decisions through gaming.

(23) J. Worth David "Simulation in the Preparation of Educational Administrators". The parenthesis have been provided by author.
(24) Z. Kukric "Training Managers through Decision-Making in Simulation" in Simulation and Gaming. A Symposium, Management Report No. 55, New York : American Management Association, 1961 p 60-64.
(25) W. R. Dill et. al, "Strategies for Self Education". Harvard Business Review Nov. - Dec. 1965 pp 30-46 and William R. Dill and Neil Doppett, "The Acquisition of Experience in a Complex Management Game". Management Science. Vol. 10 No. 1 October, 1963.
(26) For a discussion of this subject, see J.D. Steele "How valuable is Simulation as a Teaching Tool?" in Simulation and Gaming : A Symposium op. cit., pp 27-37.

The information needed for analysis and decision is distinct from two other types of information : one, the information needed for playing the games (the mechanics and rules of play); and two, the information (or knowledge) acquired during the game on modelling, strategies and decision-making. These two types of information were the subject of research by the psychologist Neil Rackham. His results are displayed[27] in Fig. 6.1.

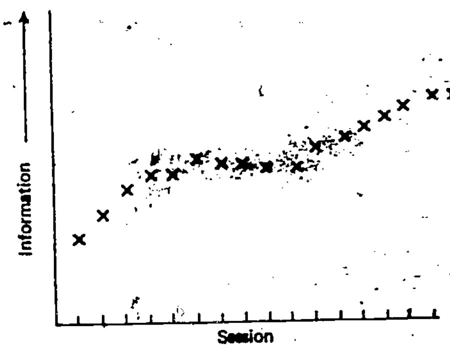

Fig 6.1 Information Curve

(27) Rackham N. "The Effectiveness of Gaming Simulation Techniques" in Armstrong RHR and J.L. Taylor (Eds) <u>Instructional Simulation Systems in Higher Education</u>, Cambridge : Cambridge Institute of Education. 1970 p 207.

The information acquisition on the early sessions concerns the rules and mechanics of the game. This soon flattens out. Then it rises again and here the information acquired is the learning on modelling and decision-making. This kink in the curve will shift as the game becomes complex (to the right) or simple (to the left).

Another curve also prepared by Rackham concerns perceived enjoyment(28) **as it varies with the number of sessions played.** This is shown(29) in Fig. 6.2.

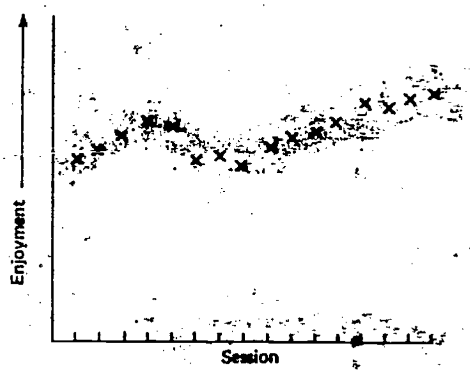

Fig. 6.2 Enjoyment Curve

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(28) The perceived enjoyment was determined on an ordinal scale using questionnaires both during and after the game.
(29) N. Rackham <u>Ibid.</u>

The enjoyment curve has a distinct "trough". The enjoyment drops after the initial novelty and excitement wears off. Then, however, it increases as the player applies his knowledge and tries out new strategies.

The trough of percieved enjoyment shifts (to the right like the information curve) with the complexity of the game. In most cases though, the trough corresponds to the flat (or low) part of the information curve. This means that at times of the game, both curves are simultaneously low. This could partly be compensated by changes in the complexity of the game and is a point when the game administrator must be most alert.

Gaming is also used to learn about modeling. Kossack (30.) observes :

"Within this admittedly artificial environment, games give participants an opportunity to compare their decision-making assumptions with those of the game model, to discuss and evaluate both and compare them critically. In other words, the game serves as a sort of catalyst to critical self-analysis and introspection".

Such analysis and introspection could lead to contemplation of the meaning of the function and relationships; their need and significance; any ambiguities and their clarifications; the contradictions and their being resolved.

Gaming can also be used for research on group-decision-making. In real life, decisions in budgeting and planning are collective group decisions. These can be simulated in a game for different types of groups.

(30) In Simulation and Gaming, A symposium. op. cit.

One variable is the size of the group - or the team in the case of the game. As this increases, the cross currents increase more than linearly, and the group-dynamics become more complex. Decisions take longer and are more difficult. But what are the relationships involved and what is the optimal or near-optimal size?

Another variable is the composition of the group. How would the decision of all administrators differ from that of all scientists, or all professors or all business managers? And why? What is the best mix not only in terms of functional background but also in terms of experience and knowledge in quantitative methods? And even emotional make-up and age?

Yet another variable is the organisation of the team. One may ask how the decision varies with different organisational patterns. One possibility is for the game administrator to appoint a "rector" or "chancellor" for each team. Another would be to make each team elect its own head. The third alternative would be to let the team evolve its own organizational structure (or a lack of one) as it makes its decisions.

Another strategy would be to have an "observer" in each team who would then share his observations during the game evaluation. Making him an observer (previously announced or planted) does give him an emotionally objective view and could add to the evaluation.

Each of these alternatives and yet others can be simulated individually or collectively with other alternatives of team size and composition. Even if they were not used for testing research hypotheses they would be a valuable experience for players in group decision-making.

6.2 Limitations of Games

A game model is only as good as the perception of its designer. This perception is not only of the objectives of the game (and needs of the players) but also of the realism of the environment necessary to meet the objectives. The realism must of course be balanced with simplicity. But even with the best balance there are many situations excluded from the game, including those of high risk and high payoff. But these are precisely the situations that many a player would wish to explore since he cannot do so in real life. As a consequence of this inability, the player is frustrated and dissatisfied with the game.

The game has a psychological limitation in that it is never considered as "real". But experience with games has shown that once the players accept the laboratory nature of the game, they quickly adjust to the constrained environment and if the game problem is made sufficiently difficult (and progressively more difficult with each play), then the players find the game not only meaningful but even enjoyable and sometimes even exciting.

The limitations of gaming is sometimes related to the way it is administered. This involves many decisions like the selection of players, the size, composition and organisation of the teams, the time allowed for each play, and even the number of plays allowed. This last factor is important in long range planning games where it is necessary to have many plays to see and learn from the consequence of earlier decisions. The factor is important even in the U.S.G. where the investment of faculty in curriculum development has a delayed effect on the curriculum quality index(31).

The number of plays allowed also has an effect on percieved enjoyment and information acquisition as discussed in Figures 6.1 and 6.2. These curves show that the highest perceived enjoyment and highest information acquisition takes place only after a number of plays. This suggests that this point of maximum enjoyment and learning will never occur if the game is not played long enough. How long will depend on the complexity of the game and the responses of participants.

The use of the game is greatly limited if the players are not carefully oriented about the game model and the rules of the game. This must be done before the starting of the game. Once the game starts, the game administrator must be responsive to the needs of the players and altert to opportunities where learning can be initiated or reinforced.

(31) This relationship is not included in the discussion of USG in Section 3 because it was considered a "detail" and not part of the basic logic of the model.

In summary, it must be recognised that there are some limitations to games but these are over weighed by the advantages and values of games. This is reflected in the fact that games are used in most Schools of Business in the U.S. In some cases they are an entire course required of students in management. Such a requirement may never be made of educational would-be managers but certain games should be made accessible to them as well as to current educational managers. It is to facilitate that process that this manuscript is written.

Annonated Bibliography

This bibliography is concerned with survey type material on gaming and related topics. The citations in the text will not be repeated unless the titles are not fully expressive of their content or the citation was too specific.

This bibliography also excludes references to RRPM 1.6 which appear in a special annotated set of references in the Appendix.

Greenlaw, Paul S., Lowell W. Herron and Richard H. Rawdon — Business Simulation in Industrial and University Education, Englewood Cliffs, N.J. : Prentice Hall Inc. 1962.

Though written for business games this book has much that is relevant to games for university management, especially the chapters on the mechanics, logistics and organization of games. It also has an annotated list of many functional games.

Hussain, K.M — Institutional Planning Models in Higher Education Paris : Centre for Educational Research and Innovation. OECD Paris 1973 (also translated in French).

This is the only survey of resource planning models in both Europe and the U.S.A. including RRPM and TUSS. It covers both the logic and problems of implementation.

Tansey P.J. (ed) — Educational Aspects of Simulation London : McGraw Hill, 1971.

This is a set of articles on simulation and gaming as used not only in teaching and in educational institutions but also in war games and international relations. It provides many insights in the educational and training values of gaming and simulation. Also included is a listing of games and simulations used in both the U.S. and Europe.

Thomas C. J. and W. L. Deemer Jr. "The Role of Operational Gaming" in Operations Research Vol. 5 No. 1 Feb. 1957.

This is a survey of gaming. It is "old" but still very valid. Even though it appears in a mathematically oriented journal, it does not require any mathematical pre-requisites for its understanding. It is highly recommended for the serious reader.

INTRODUCTION TO APPENDICES

To enable an interested party to run ~~either~~ USG or RRPM 1.6, one needs a set of technical material. This is the content of this appendix. With the help of the appendix and the text of this manuscript, one should ~~be~~ able to comprehend and run both USG and RRPM 1.6. To use these models in a game context, there are two companion manuals, one for USG, and one for the extension of USG using RRPM 1.6. These two companion manuals are available at the IMHE/OECD, Paris. Both these manuals have almost the same content : the parameters and decision variables in the model; the output and input with samples; strategies of the game; comparison of USG and RRPM 1.6 (in the RRPM 1.6 Manual only); and a glossary of terms.

On RRPM 1.6, there is much documentation, both conceptual and technical. **In fact,** there is so much that there is perhaps a need for a guide through its literature. This is done in Appendix A.

For USG the logic is illustrated by a simple numerical example. This is done in Appendix B.

There is very little available in English on the systems documentation of USG. The one flow chart available is given in Appendix C. This is followed by a program listing of USG which appears in Appendix D.

Summarizing, we have the following four appendices ;

A. Guide to Documentation on RRPM 1.6.
B. Numerical solution to ~~USG.~~
C. Systems Documentation on USG.
D. Program Listing of USG.

Appendix A

Guide to Documentation on RRPM 1.6

No documentation on RRPM 1.6 is included in this appendix because it is already published and easily available elewhere. What is perhaps needed is a guide to this literature and it is the purpose of this Appendix.

An excellent description of the model and its logic expressed in flow diagram is Introduction to the Resource Requirements Prediction Model 1.6, by Clark et. al. 1973 NCHEMS Technical Report 34A. Also included are a set of numerical examples of each type of computation. There are no mathematical pre-requisites for reading this manual. A desire to learn is all that is required.

Anyone wishing to run RRPM 1.6 should get its Systems Documentation: Resource Requirements Prediction Model 1.6 System Documentation by W.J. Collard and M.J. Haight 1973 : NCHEMS Technical Report No. 38. This includes a systems narrative and flow; the program documentation and flow; input specifications and sample input forms; record design forms; system messages and finally, a brief chapter on systems modification necessary for implementing on different other computer equipment.

Supporting the systems documentation is a computer program listing in Resource Requirements Prediction Model 1.6 Program Listings 1973 NCHEMS Technical Rport 39. This is a 303 page set of listings of all the programs and sub-programs needed to run RRPM 1.6. It does not include the JCL listings which will vary from computer to computer.

This document includes a set of demonstration data. This data produces a set of output reports. These are provided for checking and reference in Resource Requirements Prediction Model 1.6 Reports. 1973 NCHEMS Technical Report 34B.

For those who wish to implement RRPM 1.6 as a planning and budgeting technique (rather than use it as a game only), there is "A Blueprint for RRPM 1.6 Application" by R. A. Huff and M.E. Young, 1973. It includes a set of diagrams appropriate for use as visuals.

For technical considerations of implementing RRPM, but RRPM 1.3 in particular, see K.M. Hussain, A Resource Requirement Prediction Model (RRPM-1) :Guide for the Project Manager, 1971 NCHEMS Technical Report No. 20. For the experiences of pilot institutions in implementing RRPM 1.3, see K.M. Hussain and J.S. Martin, A Resource Requirement Prediction Model (RRPM 1) - Report on the Pilot Studies 1971. NCHEMS Technical Report No. 21.

RRPM is just one component of a set of institutional planning models. For an implementation of RRPM 1.6 as part of a set of other planning models, see R. Huff et. al., Implementation of NCHEMS Planning and Management Tools at California State University, Fullerton 1972

All the citations in this appendix are publications of NCHEMS at WICHE, - the National Center of Higher Education Management Systems at WICHE. These publications can be acquired (if still in print) for a nominal production cost from NCHEMS at WICHE, P.O.Box P, Boulder, Colorado, U.S.A. 80302. Also available at production cost is a copy of the RRPM program (RRPM 1.3 or 1.6) on magnetic tape.

Appendix B

Numerical Solution for USG

This appendix is designed to supplement the text discussion of the logic of USG. A simple set of environmental conditions will be used to calculate all the output generated by USG.

The format will be graphic rather than textual. The flow diagram in the text will be used so as to provide reinforcement to the text.

For clarity and reference, the calculations will be followed by list of decision variables and parameters. In each case, there will be a reference for each item to the diagrams in the text.

Problem:

Consider the following environmental conditions :

Ratio of hours spent by instructional staff for each hour spent by student in lectures = 2

lectures	=	2
self instruction	=	1.5
small groups	=	1.6
laboratories	=	1.33
exams	=	0.02
individual work		0.01

Total effort of each instructional staff for 1 academic year (average) = 2000 hours

Average annual salary of teaching staff and staff for curriculum development = $26,000

Average annual salary of student assistants = $8,000

The departmental staff had a meeting and decided on the following :

Maximum group size = 10
Curriculum period = 5 years.

The staff availability was projected in FTE as follows :

teaching = 15
curriculum development = 0
student assistants = 5

Percentage time spent by average instructional staff member
on teaching = 0.4
on research = 0.3
on other activities = 0.3

The institutional management had a policy planning meeting and discussed institutional objectives. They discussed instructional quality and determined the following weights for each hour spent by a student in the different activities :

lecture	= 1
self-instruction	= 6
small-groups	= 4
laboratories	= 4
exams	= 1
individual work	= 4

This top management group also reviewed decisions by the departmental group and after asking for some justification from this group, fully approved their decisions (as listed above).

The Office of Planning was asked to project the student enrolment for the "faculteit" under consideration. After much discussion and computations, they projected an annual enrolment of students for the planning year at all levels = 500

The Office of Institutional Research was asked for data on student effort spent and distribution of effort. They used historical data and made a survey of student attitudes. Their projections for the planning period were as follows :

Average hours spent by each student per year = 1600

Distribution of student effort (in percentages) are

lecutures	=	0.40
special-instruction	=	0.03
small-groups	=	0.10
laboratories	=	0.12
exams	=	0.20
individual work	=	0.15

Note on problem statement

The order of values given above follow fairly closely to the order in which they are listed as decision variables or parameters (Figures B3 and B4). In reality, the data is not so easily available and must be either calculated, researched or negotiated. Furthermore, many groups are typically involved. Some of this flavour is attempted in the problem definition above. Of course, it is **oversimplified**.

Given the above data, you are required to calculate the following :

1. Shortage or surplus of instructional staff hours
2. Student Staff ratio (where staff is for teaching and curriculum development)
3. Teaching staff and student assistant ratio
4. Total salary costs
5. Salary costs per student.

The numerical solution is shown in Figures B1.1, B1.2 and B1.3. They can be compared to the solution by the computer program which appears in Figure B2. Note that the values appearing in both cases have the same values. Only some of the input is shown in the computer report for purposes of checking and reference. These inputs are referred in the lists of decision variables (Figure B3) and to the computer output (Figure B2). Some values in the output are derived. An example is the percentage of research. The percentage of research and teaching is to be taken as 70% and given that teaching is 40% then the research becomes 30% (S in Figure B2) and other activities becomes 30% (T). Also, the number of groups (W) is derived data calculated by dividing the number of students (U) by the maximum group size (V). These references of output in Figure B2 and the text are shown in a table in Figure B5.

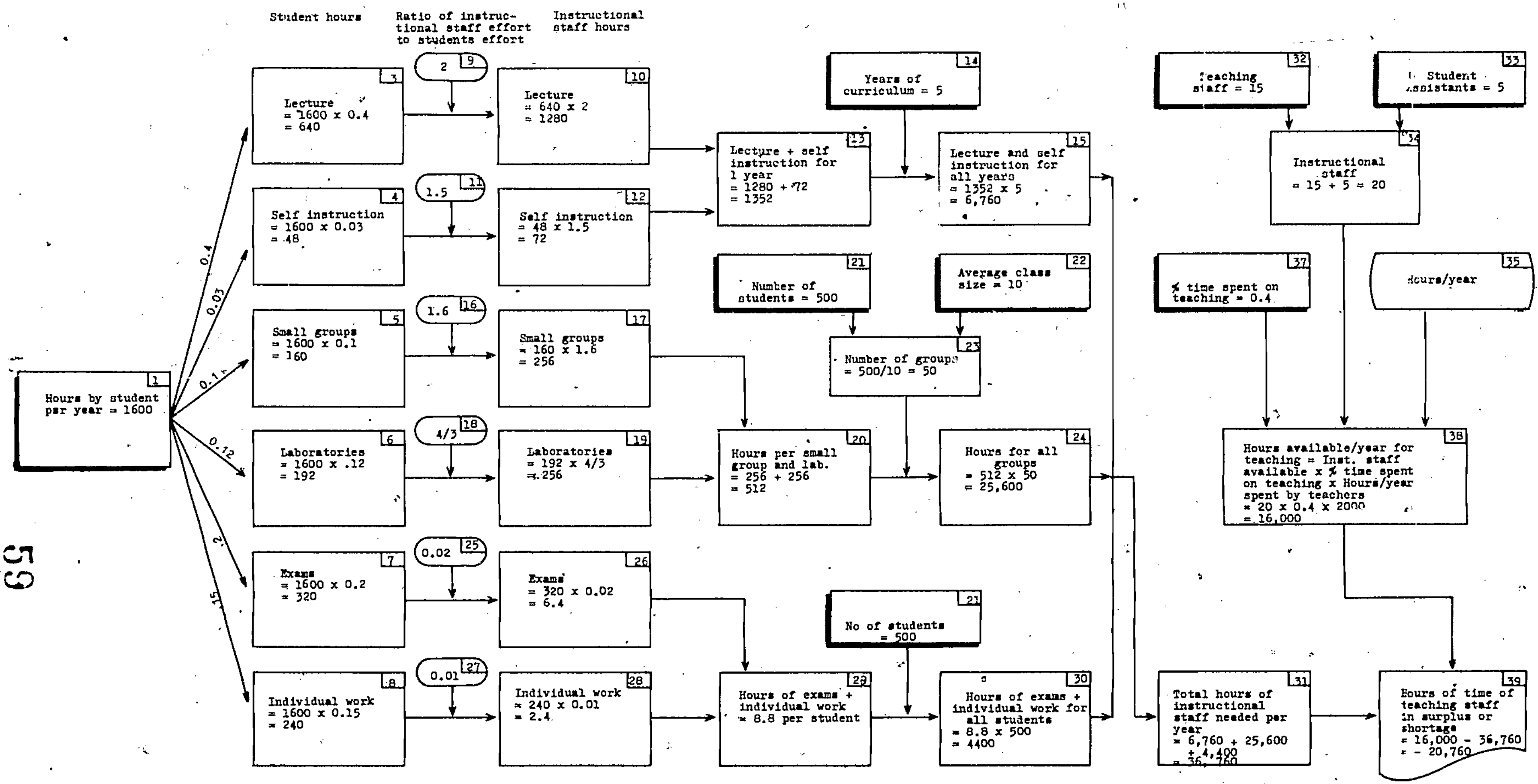


Figure B 1.1 Numerical Solution to Problem on USG (Page 1 of 3)

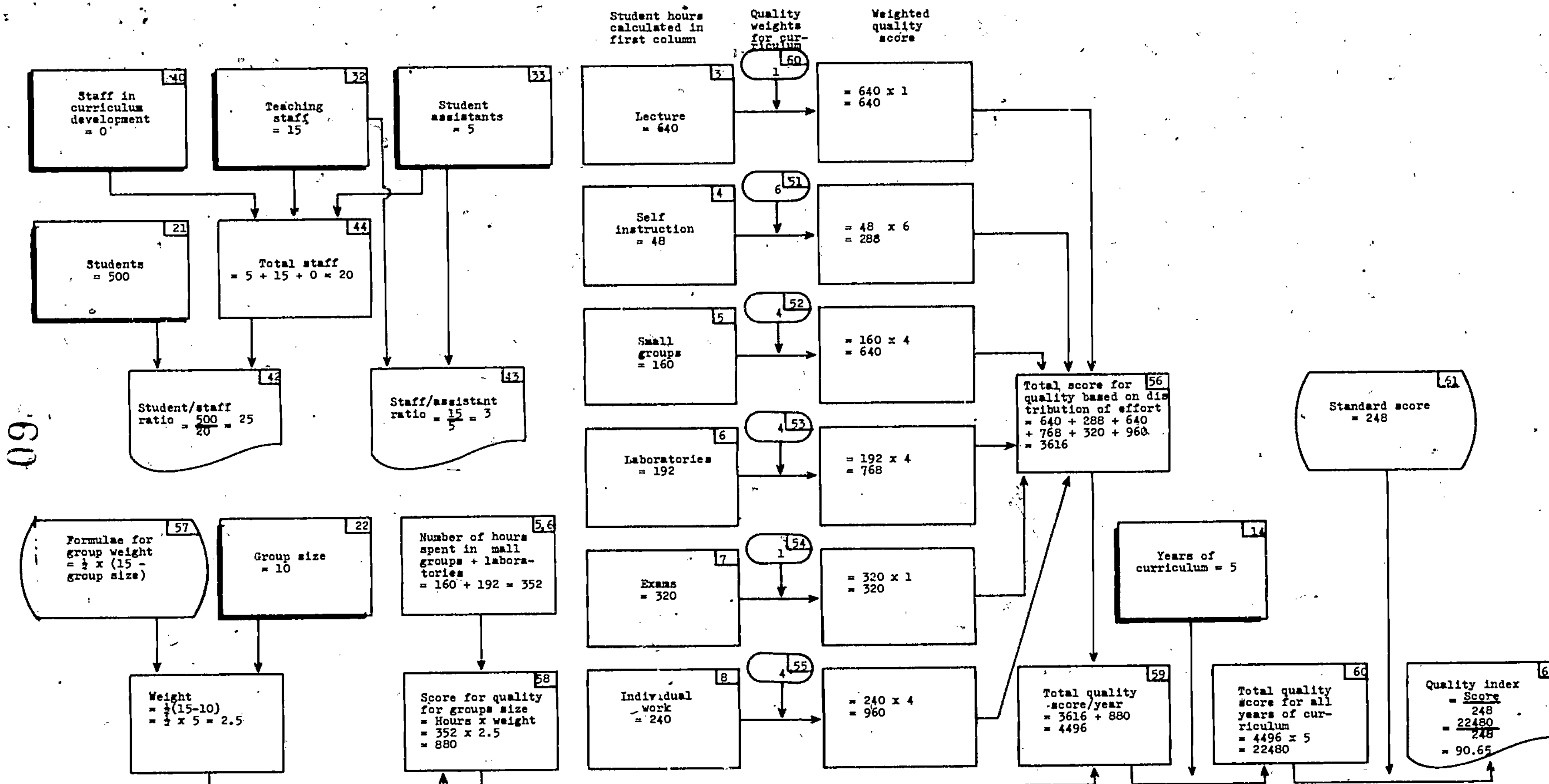


Figure B 1.2 Numerical Solution to Problem on USG (page 2 of 3)

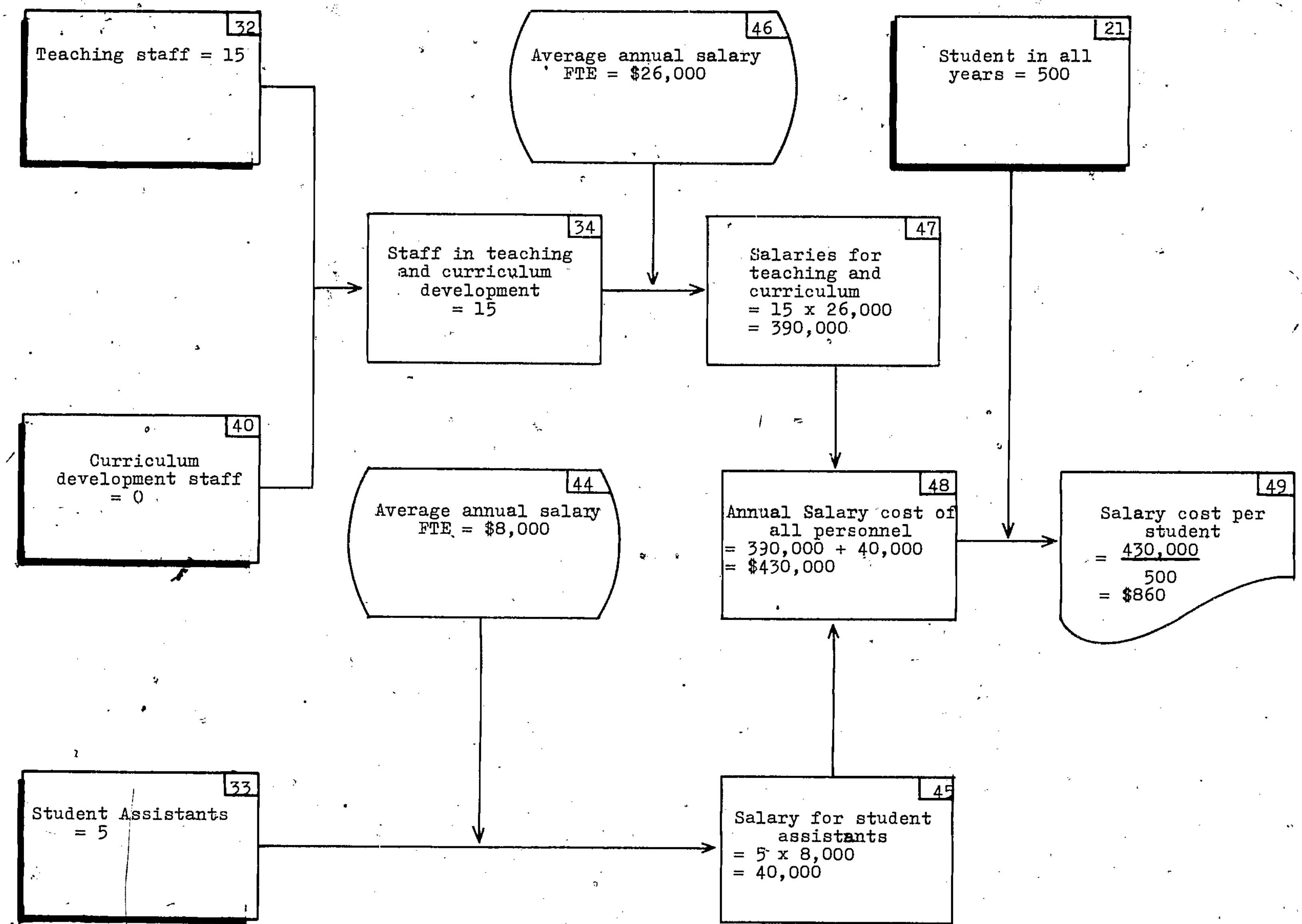


Figure B 1.3 Numerical Solution to Problem on USG (page 3 of 3)

UNIVERSITY OF UTRECHT BIOLOGY

	73-74	REFERENCE
GENERAL DATA		
SHORTAGE/SURPLUS T-HOURS (IN 100'S)	-207.60	A
STUDENT/STAFF RATIO	25.00	B
STAFF/ASSISTENT RATIO	3.00	C
CURRICULUM QUALITY	90.65	D
SALARY COSTS (USD, IN 10000'S)	43.00	E
SAL-COSTS/STUDENTS (USD, IN 100'S)	8.60	F
CURRICULUM		
STUDENTHOURS/YEAR (IN 100'S)	16.00	G
PERCENTAGE LECTURES	40.00	H
PERCENTAGE SELF INSTRUCTION	3.00	I
PERCENTAGE SMALL GROUPS	10.00	J
PERCENTAGE LABORATORY	12.00	K
PERCENTAGE EXAMINATIONS	20.00	L
PERCENTAGE INDIVIDUAL WORK	15.00	M
CURRICULUM YEARS	5.00	N
PERSONEL		
STAFF IN TEACHING	15.00	O
STUDENTASSISTENTS	5.00	P
STAFF IN CURRICULUM DEVELOPEMENT	0.00	Q
PERCENTAGE SPENT ON TEACHING	40.00	R
PERCENTAGE SPENT ON RESEARCH	30.00	S
PERCENTAGE SPENT ON OTHER ACTIVITIES	30.00	T
STUDENTS		
NUMBER OF STUDENTS	500.00	U
GROUPSIZE MAXIMUM	10.00	V
NUMBER OF GROUPS	50.00	W

Figure B 2

Computer output for problem

Figure B 3: List of Decision Variables

Decision Variable	Reference to Text Chapter 3.	Reference to output in Appendix Figure B 2
1. Number of student hours of effort per year	Figure 3.1/1	G
2. Percentage of student effort distribution between	Figure 3.1/2	
. lectures		H
. special instruction		I
. small groups		J
. laboratories		K
. exams		L
. individual work (must total to 100%)		M
3. Years of study in curriculum	Figure 3.2/14 Figure 3.8/14	N
4. Number of students for all years	Figure 3.3/21 Figure 3.4/21	U
5. Maximum group size (at all levels)	Figure 3.3/22 Figure 3.8/22	V
6. Teaching staff available (full time equivalent i.e. FTE)	Figure 3.5/32 Figure 3.6/32	O
7. Student assistants available (in FTE)	Figure 3.5/33 Figure 3.6/33	P
8. Percentage of total effort of instructional staff available for teaching	Figure 3.5/37	R
9. Staff for curriculum development available (FTE)	Figure 3.6/40	Q

Figure B 4: List of Parameters

Parameter	Reference to text
1. Ratio of hours spent by instructional staff for each hour of student in lecture	Figure 3.2/9
2. Ratio of hours spent by instructional staff for each hour spent by student in self instruction	Figure 3.2/11
3. Ratio of hours spent by instructional staff for each hour by student in small groups	Figure 3.3/16
4. Ratio of hours spent by instructional staff for each hour spent by students in laboratories	Figure 3.3/13
5. Ratio of instructional staff effort to student effort in exams	Figure 3.4/25
6. Ratio of instructional staff effort to student effort in individual work	Figure 3.4/27
7. Hours of total effort for each instructional staff for each academic year	Figure 3.5/35
8. Average annual salary for teaching student assistants	Figure 3.6/44
9. Average annual salary for teaching staff and staff in curriculum development	Figure 3.6/46
10. Weights/hr by students for	
. lecture	Figure 3.7/50
. self instruction	/51
. small groups	/52
. laboratories	/53
. exams	/54
. individual work	/55
11. Weights for group size	Figure 3.8/57
12. Standard score	Figure 3.8/61

Figure B5 : Calculated Results in USG

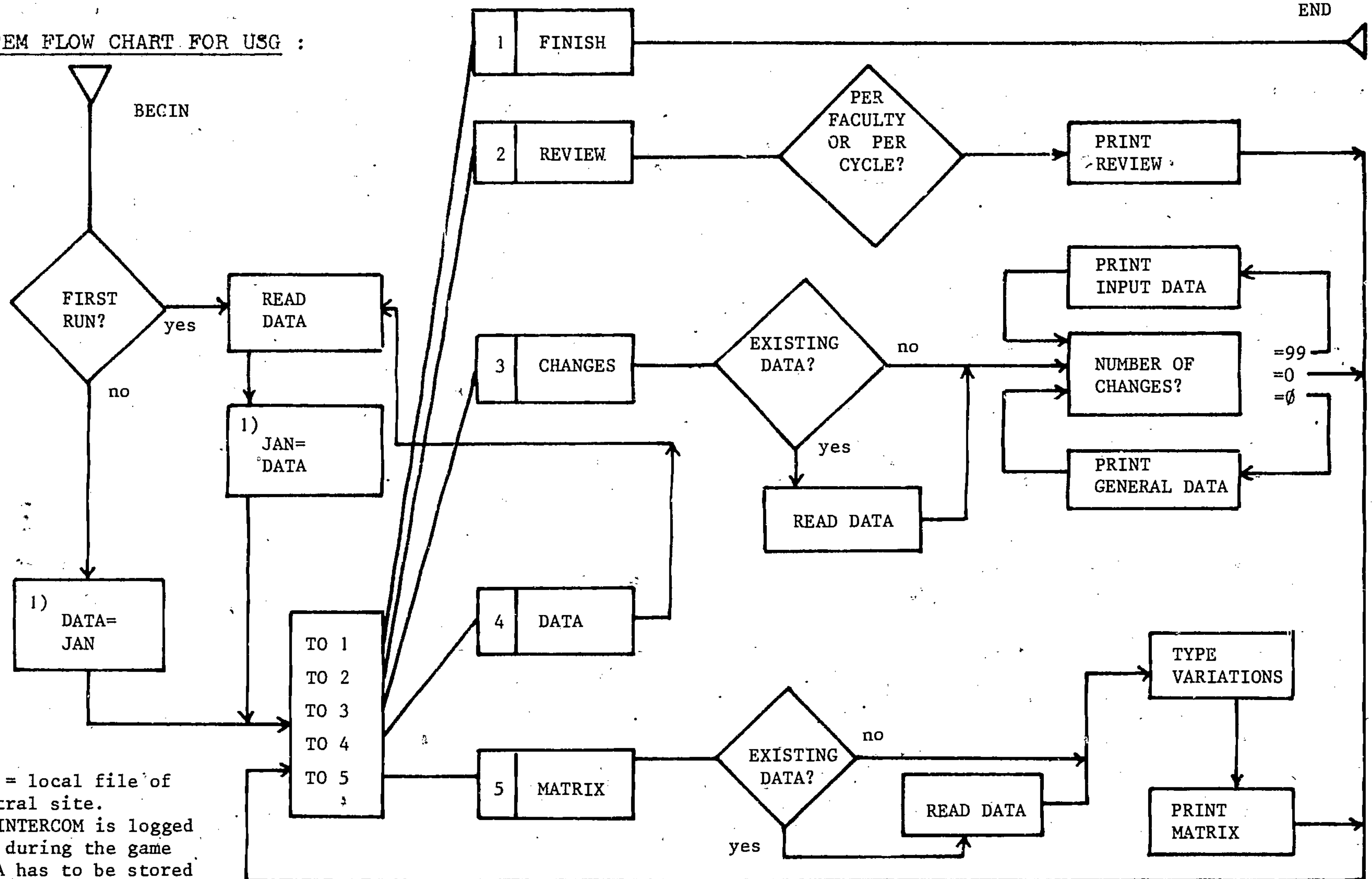
Items of calculated Results	Reference to sample in Appendix Figure B2	Reference to text
Shortage/surplus in hours	A	Figure 3.5/39
Student Staff Ratio	B	Figure 3.6/42
Staff/Assistant Ratio	C	Figure 3.6/43
Curriculum Quality (Index)	D	Figure 3.8/62
Salary Costs	E	Figure 3.6/43
Salary-Costs/student	F	Figure 3.6/49

Appendix C

Systems Documentation for USG

All that is available in English, is a system-flow chart for the U.S.G. which follows.

SYSTEM FLOW CHART FOR USG :



1)
JAN = local file of central site.
If INTERCOM is logged out during the game DATA has to be stored at central site as a file called "JAN".

Figure C

Appendix D

Program Listing for USG

The program listing for the USG that generates output in English appears in this Appendix. The program is designed for batch-processing.. Another program for terminal processing is also available but not included in this appendix.

The program listing is not inconsistent with the logic flow discussed in chapter 3. But the latter was written after the program and **for pedagogical and other reasons, it has** a different ordering and aggregation of the calculations.

```
      PROGRAM USG(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C     ENGLISH VERSION
      DIMENSION DATA(5,10,23)
      DIMENSION MDAT(23)
      DIMENSION CONTR(50)
      DIMENSION TEKST(7,5)
      REAL MDAT
      INTEGER P,Q,CONTR
      DO 700 IZ=1,5
C.....READ NAMES CF THE FACULTIES (5 CARDS).........................00 00
      READ (5,701) (TEKST(I,IZ),I=1,7)
  700 CONTINUE
      DO 104 K=1,50
      CONTR(K)=0
  104 CONTINUE
      DO 106 I=1,5
      DO 106 J=1,10
      DO 106 K=1,23
      DATA(I,J,K)=0.
  106 CONTINUE
C
C     C H O I C E
C
  120 CONTINUE
C.....WHICH PROGRAM DO YOU WANT?....................................01
C.....0001 FINISH...................................................
C.....0002 REVIEW...................................................
C.....0003 CHANGES..................................................
C.....0004 DATA.....................................................
C.....0005 MATRIX...................................................
      READ (5,202)IO
      IF (IO.NE.4) WRITE(6,600)
      GOTO (999,150,300,100,200) IO
C
C     D A T A
  100 CONTINUE
C.....WHICH FACULTY/CYCLE?..........................................02
      READ (5,202) P,Q
      IC=(P*10-10)+Q
      CONTR(IC)=1
C.....TYPE DATA!....................................................03
      READ (5,204) (DATA(P,Q,I),I=3,16)
      X=DATA(P,Q,5)
      DATA(P,Q,5)=DATA(P,Q,6)
      DATA(P,Q,6)=DATA(P,Q,7)
      DATA(P,Q,7)=X
      CALL REKEN (P,Q,1,MDAT,DATA)
      DO 115 I=17,23
      DATA (P,Q,I)=MDAT(I)
  115 CONTINUE
      GOTO 120
C
C     R E V I E W
C
  150 CONTINUE
      CALL REVIEW(TEKST,DATA,MDAT,CONTR)
      GOTO 120
```

```
C
C     M A T R I X
C
  200 CONTINUE
      CALL MATRIX(DATA,MDAT,CONTR)
      GOTO 120
C
C     C H A N G E S
C
  300 CONTINUE
C.....DO YOU WANT TO CHANGE EXISTING DATA?  YES=0001,NO=0000.......02 02
      READ (5,202) I
      IF (I.EQ.0) GOTO 320
C.....WHICH FACULTY/CYCLE?.........................................03
      READ (5,202) J,K
      DO 310 II=3,16
      MDAT(II)=DATA(J,K,II)
  310 CONTINUE
      GOTO 330
  320 CONTINUE
C.....TYPE DATA:...................................................   03
      READ (5,204) (MDAT(IJ),IJ=3,16)
  330 CONTINUE
      CALL REKEN(P,Q,0,MDAT,DATA)
      WRITE (6,210) (MDAT(JJ),JJ=17,23)
  350 CONTINUE
C.....HOW MANY CHANGES?............................................04 04
      READ (5,202) IO
      IF (IO.NE.99) GOTO 355
      WRITE (6,213) (MDAT(K),K=3,16)
      GOTO 350
  355 IF (IO.GE.0.AND.IO.LE.16) GOTO 360
      WRITE (6,214)
      GOTO 350
  360 IF (IO.EQ.0) GOTO 399
      DO 375 I=1,IO
C.....TYPE VARIABLE NR/NEW VALUE...................................05 05
      READ (5,216) IP,QP
      MDAT(IP)=QP
  375 CONTINUE
C.....IF YOU WANT TO FINISH INSERT BLANK STOPCARD..................06 06
C.....OTHERWISE CONTINUE WITH DATACARD 04 04.......................
      CALL REKEN(P,Q,0,MDAT,DATA)
      WRITE (6,210) (MDAT(JJ),JJ=17,23)
      GOTO 350
  399 GOTO 120
C
C     F I N I S H
C
  999 CONTINUE
C
C
C
C     F O R M A T S
C
  107 FORMAT (I4,7A10)
  202 FORMAT (3I4)
```

```
PROGRAM JSG          73/73   OPT=1                        FTN 4.0+P357      23/07/74  16.34.05.      PAGE     3

          204 FORMAT (14F4.0)
          210 FORMAT (1H ,7F9.2)
          213 FORMAT (14F5.0)
          214 FORMAT (1H ,31HNUMBER CF DATA NOT RIGHT (3-16))
          216 FORMAT (I4,F4.0)
          600 FORMAT (1H1)
          701 FORMAT (7A6)
      C
              STOP
              END
      C
      C
      C
```

```
       PROGRAM USG        73/73   OPT=1                  FTN 4.0+P357       23/07/74  16.34.05.      PAGE    4

     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
 4102  USG

VARIABLES     SN  TYPE            RELOCATION
 6725  CONTR     INTEGER    ARRAY                 4500  DATA       REAL       ARRAY
 4465  I         INTEGER                          4471  IC         INTEGER
 4473  II        INTEGER                          4474  IJ         INTEGER
 4470  IO        INTEGER                          4476  IP         INTEGER
 4464  IZ        INTEGER                          4467  J          INTEGER
 4475  JJ        INTEGER                          4466  K          INTEGER
 6676  MDAT      REAL       ARRAY                 4462  P          INTEGER
 4463  Q         INTEGER                          4477  QP         REAL
 7007  TEKST     REAL       ARRAY                 4472  X          REAL

FILE NAMES        MODE
    0  INPUT              2036  OUTPUT                        0  TAPE5     FMT          2036  TAPE6     FMT

EXTERNALS           TYPE   ARGS
       MATRIX               3                       REKEN                5
       REVIEW               4

STATEMENT LABELS
 4154  100                              0  104                                0  106
 4433  107     FMT  NO REFS             0  115                             4135  120
 4220  150                           4223  200                             4435  202     FMT
 4437  204     FMT                   4441  210     FMT                     4443  213     FMT
 4445  214     FMT                   4452  216     FMT                     4226  300
    0  310                           4243  320                             4245  330
 4251  350                           4260  355                             4266  360
    0  375                           4303  399                             4454  600     FMT
    0  700                           4456  701     FMT                     4304  999

STATISTICS
  PROGRAM LENGTH    2756B   1518
   BUFFER LENGTH    4074B   2108
```

```
      SUBROUTINE MATRIX(DATA,MDAT,CONTR)
      DIMENSION DATA(5,10,23)
      DIMENSION MOAT(23)
      DIMENSION CONTR(50)
      DIMENSION MATR(216),IHULP(12),NAAM(6)
      INTEGER CCNTR
      REAL MDAT,MATR,NAAM
      DATA IIG1,IIG2,IIG3,IIG4,IIG5/14,16,15,10,3/
      DATA NAAM/6HHOURS ,6HST/STA,6HSTA/AS,6HQUAL  ,6HCOST  ,6HCOST/S/
      III=0
      IIA=0
C.....HOW MANY REVIEWS?.................................................02 02
      READ (5,5) IT
      DO 100 IIT=1,IT
      IF (IIT.GT.6) GOTO 100
      IF (IIT.NE.1) GOTO 101
  102 IF (III.GT.24) WRITE (6,103)
C.....INSERT VARIATIONS BY TYPING:...................................
C.....INITIAL VALUE,LIMIT VALUE,STEP,NUMBER OF STEPS.................
C.....PERCENTAGE TIME SPENT ON TEACHING:................................03 03
      READ (5,5) IG2,IG3,IG4,IG5
C.....GROUPSIZE MAXIMUM:................................................04 04
      READ (5,5) IH2,IH3,IH4,IH5
C.....NUMBER OF STUDENTS:...............................................05 05
      READ (5,5) II2,II3,II4,II5
      III=IG5*IH5*II5
      IF (III.GT.24) GOTO 102
  104 IF (IIA.GT.6) WRITE (6,103)
C.....CURRICULUM YEARS:   (1 OR 2 STEPS ONLY)...........................06 06
      READ (5,5) IJ2,IJ3,IJ4,IJ5
C.....STUDENTHOURS:   (3 OR 6 STEPS ONLY)...............................07 07
      READ (5,5) IK2,IK3,IK4,IK5
      IIA=IJ5*IK5
      IF (IIA.NE.6) GOTO 104
  101 CONTINUE
C.....IN THE MATRIX VARIABLE NR:........................................08 08
      READ (5,5) IIG6
      IF (IIG6.GT.23) GOTO 101
   44 CONTINUE
C.....ARE OTHER DATA EXISTING?  YES=0001,NO=0000........................09 09
      READ (5,5) IY
      IF (IY.NE.1) GOTO 30
C.....WHICH FACULTY/CYCLE?..............................................10
      READ (5,5) IP,IQ
      IM=(IP*10-10)+IQ
      IF (CONTR(IM).NE.1) WRITE(6,43) IP,IQ
      IF (CONTR(IM).NE.1) GOTO 44
      DO 45 K=1,16
      MDAT(K)=DATA(IP,IQ,K)
   45 CONTINUE
      GOTO 70
   30 CONTINUE
C.....WHICH CURRICULUM?...............................................   10
      READ (5,23) (MDAT(K),K=4,9)
C.....WHICH PERSONEL?.................................................   11
C.....IF NUMBER OF REVIEWS NOT EQUAL 1 CONTINUE WITH DATACARD 08 08
      READ (5,23) (MDAT(K),K=11,13)
```

```
   70 CONTINUE
      ITEL=3
      DO 10 IG1=IG2,IG3,IG4
      DO 10 IH1=IH2,IH3,IH4
      DO 10 II1=II2,II3,II4
      DO 10 IJ1=IJ2,IJ3,IJ4
      DO 10 IK1=IK2,IK3,IK4
      HDAT(IIG1)=IG1
      MDAT(IIG2)=IH1
      MDAT(IIG3)=II1
      MDAT(IIG4)=IJ1
      MDAT(IIG5)=IK1
      CALL REKEN(P,Q,0,MDAT,DATA)
      ITEL=ITEL+1
      IF (IJ1.EQ.IJ3.AND.IK1.EQ.IK3) GOTO 16
      GOTO 15
   16 MATR(ITEL-8)=IG1
      MATR(ITEL-7)=IH1
      MATR(ITEL-6)=II1
   15 MATR(ITEL)=MDAT(IIG6)
      IF (IJ1.EQ.IJ3.AND.IK1.EQ.IK3) ITEL=ITEL+3
   10 CONTINUE
      ITEL=ITEL-3
      IF (IIT.NE.1) GOTO 21
      DO 32 IX=1,3
      IHULP(IX)=IJ2
      IHULP(IX+3)=IJ3
   32 CONTINUE
      DO 17 IX=1,6
      IXX=(IK2+(IX-1)*IK4)*100
      IHULP(IX+6)=IXX
      IF (IJ2.NE.IJ3.AND.IX.GT.3) IHULP(IX+6)=IHULP(IX+3)
   17 CONTINUE
      WRITE (6,210)
      WRITE (6,200) NAAM(IIG6-17)    ,(MDAT(K),K=4,9),(MDAT(K),K=11,13),
     ,(IHULP(K),K=1,6),(IHULP(K),K=7,12)
   21 CONTINUE
      IF (IIT.NE.1) WRITE(6,201) NAAM(IIG6-17),(MDAT(K),K=4,9),(MDAT(K),
     ,K=11,13)
      WRITE (6,19) (MATR(K),K=1,ITEL)
  100 CONTINUE
      WRITE (6,36)
      WRITE (6,36)
      WRITE (6,36)
C
C     F O R M A T S
C
    5 FORMAT (6I4)
   18 FORMAT (1H ,26X,I5,22X,I5,//,1H ,13X,6(4X,I5),/)
   19 FORMAT (1H ,3F5.0,6F9.2)
   23 FORMAT (6F4.0)
   31 FORMAT (1H ,13HCURRICULUM NR,I4,//)
   36 FORMAT (1H0)
   43 FORMAT (1H ,28HTHERE ARE NO DATA OF FACULTY,I2,6H CYCLE,/  ,1H ,5H
     ,AGAIN)
  103 FORMAT (1H ,37HNUMBER OF STEPS NOT RIGHT; TRY AGAIN!)
  200 FORMAT (1H ,19HTABLE OF CHANGING  ,A10,/  ,1H ,10HCURRICULUM,4X,6F
```

```
              ,5.0,/  ,1H ,8HPERSONEL,6X,3F5.0,/  ,/  ,1H ,3X,12HCURR YEARS  ,6I9
              ,,/  ,1H ,3X,12HSTUOENTHOURS,6I9,/  ,/  ,1H ,15HTEACH SIZE STUD,//)
          201 FORMAT (1H ,/  ,/  ,1H ,19HTABLE OF CHANGING  ,A10,/  ,1H ,10HCURR
             ,ICULUM,4X,6F5.0,/,1H ,8HPERSONEL,6X,3F5.0,//)
          210 FORMAT (1H1)
        C
              RETURN
              END
        C
        C
```

```
        SUBROUTINE MATRIX      73/73    OPT=1                        FTN 4.0+P357       23/07/74  16.34.08.       PAGE      4

        SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  MATRIX

VARIABLES     SN  TYPE             RELOCATION
    0  CONTR       INTEGER    ARRAY      F.P.                0  DATA       REAL        ARRAY      F.P.
  631  IG1         INTEGER                                 576  IG2        INTEGER
  577  IG3         INTEGER                                 600  IG4        INTEGER
  601  IG5         INTEGER                                1172  IHULP      INTEGER     ARRAY
  632  IH1         INTEGER                                 602  IH2        INTEGER
  603  IH3         INTEGER                                 604  IH4        INTEGER
  605  IH5         INTEGER                                 573  IIA        INTEGER
  310  IIG1        INTEGER                                 311  IIG2       INTEGER
  312  IIG3        INTEGER                                 313  IIG4       INTEGER
  314  IIG5        INTEGER                                 622  IIG6       INTEGER
  572  III         INTEGER                                 575  IIT        INTEGER
  633  II1         INTEGER                                 606  II2        INTEGER
  607  II3         INTEGER                                 610  II4        INTEGER
  611  II5         INTEGER                                 634  IJ1        INTEGER
  612  IJ2         INTEGER                                 613  IJ3        INTEGER
  614  IJ4         INTEGER                                 615  IJ5        INTEGER
  635  IK1         INTEGER                                 616  IK2        INTEGER
  617  IK3         INTEGER                                 620  IK4        INTEGER
  621  IK5         INTEGER                                 626  IM         INTEGER
  624  IP          INTEGER                                 625  IQ         INTEGER
  574  IT          INTEGER                                 630  ITEL       INTEGER
  640  IX          INTEGER                                 641  IXX        INTEGER
  623  IY          INTEGER                                 627  K          INTEGER
  642  MATR        REAL       ARRAY                          0  MDAT       REAL        ARRAY      F.P.
 1206  NAAM        REAL       ARRAY                        636  P          REAL
  637  Q           REAL

FILE NAMES         MODE
       TAPE5       FMT                   TAPE6      FMT

EXTERNALS              TYPE     ARGS
       REKEN                     5

STATEMENT LABELS
  475  5        FMT                      0  10                           166  15
  161  16                                0  17                           477  18      FMT  NO REFS
  504  19       FMT                    254  21                           507  23      FMT
  113  30                              511  31      FMT  NO REFS           0  32
  515  36       FMT                    517  43      FMT                   63  44
    0  45                              117  70                           267  100
   57  101                              25  102                          526  103     FMT
   43  104                             534  200     FMT                  555  201     FMT
  567  210      FMT

STATISTICS
  PROGRAM LENGTH    1222B      658
```

```
      SUBROUTINE REKEN(P,Q,M,MDAT,DATA)
      DIMENSION DATA(5,10,23)
      DIMENSION MDAT(23)
      DIMENSION IB(9),IC(9),IA(23),IE(9)
      REAL IA,IB,IC,IE,IBT,ICT,MDAT
      INTEGER P,Q,M
      DO 10 II=3,16
      IA(II)=DATA(P,Q,II)
      IF (M.NE.1) IA(II)=MDAT(II)
   10 CONTINUE
      ITIT=0
      DO 15 K=4,9
      ITIT=ITIT+IA(K)
   15 CONTINUE
      IF (ITIT.NE.100.) WRITE (6,60)
      R=IA(15)/IA(16)
      IF (IA(15).LE.0) R=0
      IR=R
      IF ((IR-R).LT.0) IR=IR+1
      IA(17)=IR
      DO 20 I=4,9
      IE(I)=IA(I)*IA(3)
   20 CONTINUE
      IB(4)=IE(4)*IA(10)* 3.0/1.5
      IB(5)=IE(5)*IA(17)* 4.0/2.5
      IB(6)=IE(6)*IA(17)* 2.0/1.5
      IB(7)=IE(7)*IA(10)* 1.5/1.0
      IB(8)=IE(8)*IA(15)* 0.02
      IB(9)=IE(9)*IA(15)* 0.01
C
      PKWGR= 4.0 + (15 - IA(16)) * 0.5
C
      IC(4)=IE(4) * 1.0
      IC(5)=IE(5)*PKWGR
      IC(6)=IE(6)*PKWGR
      IC(7)=IE(7)*6.0
      IC(8)=IE(8)*1.0
      IC(9)=IE(9)*4.0
C
      IBT=0
      ICT=0
      DO 30 I=4,9
      IBT=IBT+IB(I)
      ICT=ICT+IC(I)
   30 CONTINUE
C
      IA(18)=((IA(11)+IA(12))*IA(14)*20. - IBT)/100.
      IA(19)=ICT*IA(10)/248.
      IA(20)=IA(15)/(IA(11)+IA(12)+IA(13))
      IA(21)=IA(11)/IA(12)
      IA(22)=((IA(11)+IA(13))*26.+IA(12)*8.)/10.
      IA(23)=IA(22)*100./IA(15)
      DO 40 IJ=17,23
      IF (M.EQ.1) DATA(P,Q,IJ)=IA(IJ)
      MDAT(IJ)=IA(IJ)
   40 CONTINUE
C
```

```
      60 FORMAT (1H ,22HCURRICULUM NOT CORRECT)
         RETURN
         END
C
C
C
```

```
      SUBROUTINE REKEN       73/73    OPT=1                     FTN 4.0+P357       23/07/74  16.34.13.       PAGE      3

      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  REKEN

VARIABLES      SN  TYPE          RELOCATION
    0  DATA        REAL        ARRAY     F.P.         230  I          INTEGER
  255  IA          REAL        ARRAY                  233  IB         REAL       ARRAY
  221  IBT         REAL                               244  IC         REAL       ARRAY
  222  ICT         REAL                               304  IE         REAL       ARRAY
  223  II          INTEGER                            232  IJ         INTEGER
  227  IR          INTEGER                            224  ITIT       INTEGER
  225  K           INTEGER                              0  M          INTEGER              F.P.
    0  MDAT        REAL        ARRAY     F.P.           0  P          INTEGER              F.P.
  231  PKWGR       REAL                                 0  Q          INTEGER              F.P.
  226  R           REAL

FILE NAMES         MODE
       TAPE6       FMT

STATEMENT LABELS
    0  10                                 0  15                                  0  20
    0  30                                 0  40                                171  60       FMT

STATISTICS
  PROGRAM LENGTH    3318     217
```

```
      SUBROUTINE REVIEW(TEKST,DATA,MDAT,CONTR)
      DIMENSION DATA(5,10,23)
      DIMENSION MDAT(23)
      DIMENSION CONTR(50)
      DIMENSION TEKST(7,5)
      DIMENSION ONDZ(5),REST(5),JF(5),IRT(5),IR(5,5),DAT(23,5)
      DIMENSION IIB(5),IIE(5)
      INTEGER SIM2,YEAR,CONTR
C
      YEAR=72
      IOUT=0
  100 CONTINUE
C.....ARE YOU GOING TO PRINT REVIEWS PER FACULTY OR PER CYCLE?.....02 02
C.....PER FACULTY=0001     PER CYCLE=0002..........................
      READ (5,306) ISW
      IF (ISW.LT.1.OR.ISW.GT.2) GOTO 100
  313 IF (IOUT.EQ.1) WRITE (6,314)
      IOUT=0
C.....HOW MANY REVIEWS?...........................................03 03
      READ (5,306) IFT
C.....ISW=1    WHICH FACULTIES?...................................04
C.....ISW=2    WHICH CYCLES?......................................   04
      READ (5,306) (JF(I),I=1,IFT)
      DO 105 I=1,IFT
C.....HOW MANY COLUMNS?...........................................05 05
      READ (5,306) IRT(I)
C.....ISW=1    WHICH CYCLES SUCCESSIVELY?.........................06
C.....ISW=2    WHICH FACULTIES SUCCESSIVELY?......................   06
C.....IF NUMBER OF REVIEWS NOT EQUAL 1 CONTINUE WITH DATACARD 06
      IRTI=IRT(I)
      READ (5,306) (IR(I,J),J=1,IRTI)
C
  105 CONTINUE
C.....COSTS SUPPRESSED?...........................................07 07
      READ (5,306) ISUP
      IF (IOUT.EQ.1)  GOTO 313
      WRITE (6,36)
      WRITE (6,36)
      WRITE (6,36)
      WRITE (6,36)
      DO 200 I=1,IFT
      IP=JF(I)
      SIM2=IRT(I)
      IF (ISW.EQ.2) GOTO 151
      DO 210 KL=1,5
      IIB(KL)=IR(I,KL)+YEAR
      IIE(KL)=-IR(I,KL)-YEAR-1
  210 CONTINUE
      WRITE (6,81) (TEKST(K,IP),K=2,7),(IIB(II),II=1,SIM2)
      WRITE (6,80) (IIE(II),II=1,SIM2)
      GOTO 154
  151 IF (IP.GE.6) GOTO 152
      IAB=IP+YEAR
      IIAB=IAB+1
      WRITE (6,74) IAB,IIAB
      GOTO 153
  152 IAB=I
```

```
      WRITE (6,95) IAB
  153 WRITE (6,96) (IR(I,J),J=1,SIM2)
  154 DO 175 II=3,23
      DO 175 J=1,SIM2
      JJ=IR(I,J)
      IF (ISW.EQ.2) GOTO 170
      DAT(II,J)=DATA(IP,JJ,II)
      GOTO 175
  170 DAT(II,J)=DATA(JJ,IP,II)
  175 CONTINUE
      DO 176 K=1,SIM2
      ONDZ(K)=70.-DAT(14,K)
      REST(K)=30.
  176 CONTINUE
C
C     P R I N T   R E V I E W
C
      WRITE (6,36)
      WRITE (6,92) (DAT(18,J),J=1,SIM2)
      WRITE (6,90) (DAT(20,J),J=1,SIM2)
      WRITE (6,91) (DAT(21,J),J=1,SIM2)
      WRITE (6,79) (DAT(19,J),J=1,SIM2)
      IF (ISUP.EQ.1) GOTO 99
      WRITE (6,97) (DAT(22,J),J=1,SIM2)
      WRITE (6,98) (DAT(23,J),J=1,SIM2)
   99 CONTINUE
      WRITE (6,36)
      WRITE (6,82) (DAT(3,J),J=1,SIM2)
      WRITE (6,84) (DAT(4,J),J=1,SIM2)
      WRITE (6,86) (DAT(7,J),J=1,SIM2)
      WRITE (6,85) (DAT(5,J),J=1,SIM2)
      WRITE (6,87) (DAT(6,J),J=1,SIM2)
      WRITE (6,88) (DAT(8,J),J=1,SIM2)
      WRITE (6,89) (DAT(9,J),J=1,SIM2)
      WRITE (6,70) (DAT(10,J),J=1,SIM2)
      WRITE (6,36)
      WRITE (6,71) (DAT(11,J),J=1,SIM2)
      WRITE (6,73) (DAT(12,J),J=1,SIM2)
      WRITE (6,72) (DAT(13,J),J=1,SIM2)
      WRITE (6,75) (DAT(14,J),J=1,SIM2)
      WRITE (6,76) (ONDZ(J),J=1,SIM2)
      WRITE (6,77) (REST(J),J=1,SIM2)
      WRITE (6,36)
      WRITE (6,93) (DAT(15,J),J=1,SIM2)
      WRITE (6,94) (DAT(16,J),J=1,SIM2)
      WRITE (6,78) (DAT(17,J),J=1,SIM2)
      WRITE (6,36)
      WRITE (6,36)
      WRITE (6,36)
      WRITE (6,36)
  200 CONTINUE
C
C     F O R M A T S
C
   36 FORMAT (1H0)
   70 FORMAT (1H ,16HCURRICULUM YEARS,21X,5F7.2)
   71 FORMAT (1H ,8HPERSONEL,/  ,1H ,17HSTAFF IN TEACHING,20X,5F7.2)
```

```
   72 FORMAT (1H ,32HSTAFF IN CURRICULUM DEVELOPEMENT,5X,5F7.2)
   73 FORMAT (1H ,17HSTUDENTASSISTENTS,20X,5F7.2)
   74 FORMAT (1H ,13HACADEMIC YEAR,I4,1H-,I4,//)
   75 FORMAT (1H ,28HPERCENTAGE SPENT ON TEACHING,9X,5F7.2)
   76 FORMAT (1H ,28HPERCENTAGE SPENT ON RESEARCH,9X,5F7.2)
   77 FORMAT (1H ,36HPERCENTAGE SPENT ON OTHER ACTIVITIES,1X,5F7.2)
   78 FORMAT (1H ,16HNUMBER OF GROUPS,21X,5F7.2)
   79 FORMAT (1H ,18HCURRICULUM QUALITY,19X,5F7.2)
   80 FORMAT (1H+,37X,5I7)
   81 FORMAT (1H ,6A6,///,35X,5I7)
   82 FORMAT (1H ,10HCURRICULUM,/,1H ,28HSTUDENTHOURS/YEAR (IN 100'S),9X
     ,,5F7.2)
   84 FORMAT (1H ,19HPERCENTAGE LECTURES,18X,5F7.2)
   85 FORMAT (1H ,23HPERCENTAGE SMALL GROUPS,14X,5F7.2)
   86 FORMAT (1H ,27HPERCENTAGE SELF INSTRUCTION,10X,5F7.2)
   87 FORMAT (1H ,21HPERCENTAGE LABORATORY,16X,5F7.2)
   88 FORMAT (1H ,23HPERCENTAGE EXAMINATIONS,14X,5F7.2)
   89 FORMAT (1H ,26HPERCENTAGE INDIVIDUAL WORK,11X,5F7.2)
   90 FORMAT (1H ,19HSTUDENT/STAFF RATIO,18X,5F7.2)
   91 FORMAT (1H ,21HSTAFF/ASSISTENT RATIO,16X,5F7.2)
   92 FORMAT (1H ,12HGENERAL DATA,/,1H ,35HSHORTAGE/SURPLUS T-HOURS (IN
     ,100'S),2X,5F7.2)
   93 FORMAT (1H ,8HSTUDENTS,/  ,1H ,18HNUMBER OF STUDENTS,19X,5F7.2)
   94 FORMAT (1H ,17HGROUPSIZE MAXIMUM,20X,5F7.2)
   95 FORMAT (1H ,12HESTIMATES NR,I4,//)
   96 FORMAT (1H ,28X,10HFACULTY NR,5(6X,I1))
   97 FORMAT (1H ,30HSALARY COSTS (USD, IN 10000'S),7X,5F7.2)
   98 FORMAT (1H ,34HSAL-COSTS/STUDENTS (USD, IN 100'S),3X,5F7.2)
  306 FORMAT (5I4)
  311 FORMAT (1H ,28HTHERE ARE NO DATA OF FACULTY,I2,6H CYCLE,I2,11H FOR
     , REVIEW,I2)
  312 FORMAT (1H ,26HTHERE ARE NO DATA OF CYCLE,I2,8H FACULTY,I2,11H FOR
     , REVIEW,I2)
  314 FORMAT (1H ,9HTRY AGAIN)
      RETURN
      END
```

```
SUBROUTINE REVIEW     73/73   OPT=1                FTN 4.0+P357     23/07/74  16.34.19.      PAGE     4

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  REVIEW

VARIABLES      SN  TYPE           RELOCATION
     0  CONTR      INTEGER   ARRAY   F.P.       1602  DAT      REAL      ARRAY
     0  DATA       REAL      ARRAY   F.P.       1512  I        INTEGER
  1522  IAB        INTEGER                      1511  I[illegible]  INTEGER
  1521  II         INTEGER                      1523  IIAB     INTEGER
  1765  IIB        INTEGER   ARRAY              1772  IIE      INTEGER   ARRAY
  1507  IOUT       INTEGER                      1516  IP       INTEGER
  1551  IR         INTEGER   ARRAY              1544  IRT      INTEGER   ARRAY
  1513  IRTI       INTEGER                      1515  ISUP     INTEGER
  1510  ISW        INTEGER                      1514  J        INTEGER
  1537  JF         INTEGER   ARRAY              1524  JJ       INTEGER
  1520  K          INTEGER                      1517  KL       INTEGER
     0  MDAT       INTEGER   ARRAY   F.P.       1525  ONDZ     REAL      ARRAY
  1532  REST       REAL      ARRAY              1505  SIM2     INTEGER
     0  TEKST      REAL      ARRAY   F.P.       1506  YEAR     INTEGER

FILE NAMES         MODE
    TAPE5          FMT                 TAPE6     FMT

STATEMENT LABELS
  1226   36     FMT                 1230   70     FMT               1235   71     FMT
  1243   72     FMT                 1251   73     FMT               1256   74     FMT
  1263   75     FMT                 1271   76     FMT               1277   77     FMT
  1306   78     FMT                 1313   79     FMT               1320   80     FMT
  1323   81     FMT                 1326   82     FMT               1335   84     FMT
  1342   85     FMT                 1347   86     FMT               1355   87     FMT
  1362   88     FMT                 1367   89     FMT               1375   90     FMT
  1402   91     FMT                 1407   92     FMT               1417   93     FMT
  1425   94     FMT                 1432   95     FMT               1436   96     FMT
  1442   97     FMT                 1450   98     FMT                340   99
    17  100                            0  105                        140  151
   147  152                          152  153                        166  154
   204  170                          211  175                          0  176
     0  200                            0  210                       1456  306     FMT
  1460  311     FMT  NO REFS        1470  312     FMT  NO REFS        25  313
  1500  314     FMT

STATISTICS
  PROGRAM LENGTH    2010B    1032
```

```
SCOPE  3.4     -     CONTROL-CARD-INITIATED LOAD            LOADER    L355        23/07/74  16.34.43.        PAGE      1

FWA OF THE LOAD              101                         36216B WORDS WERE REQUIRED FOR LOADING
LWA+1 OF THE LOAD          25313

TRANSFER ADDRESS -- USG                  4203

NO. TABLE MOVES               75


PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK          ADDRESS     LENGTH          FILE                         PREFIX TABLE CONTENTS

USG                101       7052           LGO        23/07/74  16.34.05. SCOPE 3.4 FTN     4.0P357 6464   I
                                                       OPT=1
MATRIX            7153       1222           LGO        23/07/74  16.34.08. SCOPE 3.4 FTN     4.0P357 6464   I
                                                       OPT=1
REKEN            10375        331           LGO        23/07/74  16.34.13. SCOPE 3.4 FTN     4.0P357 6464   I
                                                       OPT=1
REVIEW           10726       2010           LGO        23/07/74  16.34.19. SCOPE 3.4 FTN     4.0P357 6464   I
                                                       OPT=1
/Q8.IO./         12736        134
/IOCON./         13072         42
COMIO=           13134        134       SL-FORTRAN     11/11/73  16.39.19. SCOPE 3.4 COMPASS 3.0-361
                                                       COMMON CODED I/O ROUTINES AND CONSTANTS.63-CHAR
FLTIN=           13270        153       SL-FORTRAN     11/11/73  16.39.43. SCOPE 3.4 COMPASS 3.0-361
                                                       COMMON FLOATING INPUT CONVERTER.
FMTAP=           13443        345       SL-FORTRAN     11/11/73  16.39.51. SCOPE 3.4 COMPASS 3.0-361
                                                       CRACK APLIST AND FORMAT FOR KODER/KRAKER.
INCOM=           14010        260       SL-FORTRAN     11/11/73  16.40.14. SCOPE 3.4 COMPASS 3.0-361
                                                       COMMON INPUT FORMATTING CODE
INPC=            14270        163       SL-FORTRAN     11/11/73  16.40.30. SCOPE 3.4 COMPASS 3.0-361
                                                        FORMATTED READ FORTRAN RECORD
KODER=           14453        460       SL-FORTRAN     11/11/73  16.40.42. SCOPE 3.4 COMPASS 3.0-361
                                                       OUTPUT FORMAT INTERPRETER.
OUTCOM=          15133        141       SL-FORTRAN     11/11/73  16.41.56. SCOPE 3.4 COMPASS 3.0-361
                                                       COMMON OUTPUT CODE
GOTOER=          15274         13       SL-FORTRAN     11/11/73  16.42.50. SCOPE 3.4 COMPASS 3.0-361
                                                       COMPUTED GO TO ERROR PROCESSOR.
FLTOUT=          15307        312       SL-FORTRAN     11/11/73  16.39.46. SCOPE 3.4 COMPASS 3.0-361
                                                       COMMON FLOATING OUTPUT CODE
FORSYS=          15621        536       SL-FORTRAN     11/11/73  16.39.56. SCOPE 3.4 COMPASS 3.0-361
                                                       FORTRAN OBJECT LIBRARY UTILITIES.
GETFIT=          16357         33       SL-FORTRAN     11/11/73  16.40.12. SCOPE 3.4 COMPASS 3.0-361
                                                       LOCATE AN FIT GIVEN A FILE NAME.
KRAKER=          16412        373       SL-FORTRAN     11/11/73  16.40.49. SCOPE 3.4 COMPASS 3.0-361
                                                        PROCESS FORMATTED FORTRAN INPUT
OUTC=            17005        171       SL-FORTRAN     11/11/73  16.41.49. SCOPE 3.4 COMPASS 3.0-361
                                                        FORMATTED WRITE FORTRAN RECORD
/JMPS.RM/        17176         14
LBUF.SQ          17212        133       SL-SYSIO       21/08/73  22.06.52. SCOPE 3.4 COMPASS 3.73219
/CON.RM/         17345          6
CIO.RM           17353         25       SL-SYSIO       21/08/73  22.07.48. SCOPE 3.4 COMPASS 3.73219
/AD3.RM/         17400         10
CHWR.SQ          17410          7       SL-SYSIO       21/08/73  22.07.56. SCOPE 3.4 COMPASS 3.73219
/PUT.RT/         17417         11
```

BLOCK	ADDRESS	LENGTH	FILE	PREFIX TABLE CONTENTS
OPEX.SQ	17430	135	SL-SYSIO	21/08/73 22.08.33. SCOPE 3.4 COMPASS 3.73219
RLEQ.RM	17565	42	SL-SYSIO	21/08/73 22.08.47. SCOPE 3.4 COMPASS 3.73219
/CLSF.FO/	17627	7		
CLSF.RM	17636	23	SL-SYSIO	21/08/73 22.09.50. SCOPE 3.4 COMPASS 3.73219
/GET.BT/	17661	5		
BTRT.SQ	17666	117	SL-SYSIO	21/08/73 22.11.12. SCOPE 3.4 COMPASS 3.73219
LXER.SQ	20005	203	SL-SYSIO	21/08/73 22.11.41. SCOPE 3.4 COMPASS 3.73219
/SKFL.FO/	20210	7		
SKFL.SQ	20217	46	SL-SYSIO	21/08/73 22.12.02. SCOPE 3.4 COMPASS 3.73219
MOVE.RM	20265	32	SL-SYSIO	11/02/74 10.27.09. SCOPE 3.4 COMPASS 3.73219
WAR.SQ	20317	256	SL-SYSIO	11/02/74 10.27.53. SCOPE 3.4 COMPASS 3.73219
ERR.RM	20575	367	SL-SYSIO	21/08/73 22.07.49. SCOPE 3.4 COMPASS 3.73219
MCT.RM	21164	233	SL-SYSIO	21/08/73 22.07.56. SCOPE 3.4 COMPASS 3.73219
/OPEN.FO/	21417	7		
OPEN.RM	21426	301	SL-SYSIO	21/08/73 22.08.10. SCOPE 3.4 COMPASS 3.73219
OPEN.SQ	21727	230	SL-SYSIO	21/08/73 22.08.22. SCOPE 3.4 COMPASS 3.73219
CLSF.SQ	22157	136	SL-SYSIO	21/08/73 22.09.52. SCOPE 3.4 COMPASS 3.73219
/CLSV.FO/	22315	7		
CLSV.SQ	22324	115	SL-SYSIO	21/08/73 22.10.01. SCOPE 3.4 COMPASS 3.73219
/GET.RT/	22441	11		
Z.SQ	22452	76	SL-SYSIO	21/08/73 22.10.48. SCOPE 3.4 COMPASS 3.73219
FSU.SQ	22550	111	SL-SYSIO	21/08/73 22.11.05. SCOPE 3.4 COMPASS 3.73219
/PUT.FO/	22661	7		
PUT.SQ	22670	1266	SL-SYSIO	11/02/74 10.27.12. SCOPE 3.4 COMPASS 3.73219
/GET.FO/	24156	7		
GET.SQ	24165	1067	SL-SYSIO	11/02/74 10.28.06. SCOPE 3.4 COMPASS 3.73219
SYS.RM	25254	37	SL-NUCLEUS	16/09/73 10.13.40. SCOPE 3.4 COMPASS 3.73219 PROCESS SYSTEM REQUEST.

2.288 CP SECONDS LOAD TIME